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RESEARCH MEMORANDUM

LOW-SUBSONIC INVESTIGATION TO DETERMINE THE CHORDWISE PRESSURE DISTRIBUTION AND EFFECTIVENESS OF SPOILERS ON A THIN, LOW-ASPECT-RATIO, UNSWEPT, UNTAPERED, SEMISPAN WING AND ON THE WING WITH LEADING- AND TRAILING-EDGE FLAPS

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Langley Field, Va.

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

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LOW-SUBSONIC INVESTIGATION TO DETERMINE THE CHORDWISE PRESSURE DISTRIBUTION AND EFFECTIVENESS OF SPOILERS ON A THIN, LOW-ASPECT-RATIO, UNSWEPT, UNTAPERED, SEMISPAN WING AND ON THE WING WITH LEADING- AND TRAILING-EDGE FLAPS

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SUMMARY

An investigation was made in the Langley 300-MPH 7- by 10-foot tunnel to determine the effect of spoilers on the static longitudinal and lateral aerodynamic characteristics and the chordwise pressure distribution on a thin, untapered, unswept, semispan wing having an aspect ratio of 3.33 and NACA 65A004 airfoil sections. The wing was equipped with leading-edge flaps and trailing-edge flaps.

Results of the investigation, without discussion, are presented in the form of static longitudinal and lateral aerodynamic characteristics and tabulated pressure coefficients, section normal-force coefficients, and section pitching-moment coefficients.

INTRODUCTION

Considerable interest has been shown in the use of spoilers for lateral control and gust alleviation. The spoiler is more effective as a lateral control when it is located in a more rearward position, and, as pointed out in references 1 and 2, the spoiler is more effective as a gust alleviator (reduces the lift-curve slope) when it is located in a more forward position.

The present investigation was made in the Langley 300-MPH 7- by 10-foot tunnel to obtain the static longitudinal and lateral aerodynamic characteristics and the chordwise pressure distribution at the 60-percent-semispan station over a thin, low-aspect-ratio, unswept, untapered, semispan wing with a 10-percent-chord projection spoiler of various spans located at various chordwise locations on the wing with leading- and trailing-edge flaps.

The results of the investigation are presented without discussion. Pressure coefficients, section normal-force coefficients, and section pitching-moment coefficients are presented in tabular form.

SYMBOLS

c chord, ft

c_w plain-wing chord, ft

c_f trailing-edge-flap chord, ft

c_N leading-edge-flap chord, ft

b wing span, ft

S wing area, sq ft

C_L lift coefficient, $\frac{\text{Twice semispan lift}}{q_\infty S}$

$C_{L_{\alpha,0}}$ slope of lift curve of basic model (measured at $\alpha = 0^\circ$) per degree

$C_{L_{\alpha,S}}$ slope of lift curve of model with spoiler (measured at $\alpha = 0^\circ$) per degree

C_D drag coefficient, $\frac{\text{Twice semispan drag}}{q_\infty S}$

ΔC_D jet-boundary correction applied to drag coefficient

C_m pitching-moment coefficient of wing referred to wing quarter-chord, $\frac{\text{Twice semispan pitching moment}}{q_\infty S c_w}$

C_l rolling-moment coefficient, $\frac{\text{Rolling moment caused by spoiler}}{q_\infty Sb}$

C_n yawing-moment coefficient, $\frac{\text{Yawing moment caused by spoiler}}{q_\infty Sb}$

C_p pressure coefficient, $\frac{p_{t,\infty} - p}{q_\infty}$ (where subscripts u and l denote upper and lower surfaces, respectively)

l_f distance from wing quarter-chord to hinge line of trailing-edge flap measured parallel to trailing-edge-flap chord, ft

l_N distance from wing quarter-chord to hinge line of leading-edge flap measured parallel to leading-edge-flap chord, ft

x longitudinal distance, ft

x_f distance from hinge line of trailing-edge flap to center of load on trailing-edge flap, ft

x_N distance from hinge line of leading-edge flap to center of load on leading-edge flap, ft

y lateral distance, ft

$p_{t,\infty}$ free-stream total pressure, lb/sq ft

p local static pressure, lb/sq ft

q_∞ free-stream dynamic pressure, $\frac{\rho V_\infty^2}{2}$, lb/sq ft

ρ mass density of air, slugs/cu ft

V_∞ free-stream velocity, ft/sec

δ_f trailing-edge-flap deflection (positive direction, trailing edge down), deg

δ_N leading-edge-flap deflection (positive direction, nose of flap down), deg

α angle of attack of chord plane set in tunnel, deg

$\Delta\alpha$ jet-boundary correction applied to angle of attack, deg

α_c corrected angle of attack, deg

$c_{N,f}$ section normal-force coefficient of trailing-edge flap based on trailing-edge-flap chord

$c_{N,N}$ section normal-force coefficient of leading-edge flap based on leading-edge-flap chord

$c_{N,w'}$ section normal-force coefficient of that portion of wing between leading-edge and trailing-edge flaps based on plain-wing chord

$c_{N,w}$ wing section normal-force coefficient based on plain-wing chord (chord force of leading-edge flap and trailing-edge flap neglected),

$$c_{N,w'} + c_{N,f}\left(\frac{c_f}{c_w}\right) \cos \delta_f + c_{N,N}\left(\frac{c_N}{c_w}\right) \cos \delta_N$$

$c_{m,f}$ section pitching-moment coefficient of trailing-edge flap based on trailing-edge-flap chord (moments taken about trailing-edge-flap hinge line)

$c_{m,N}$ section pitching-moment coefficient of leading-edge flap based on leading-edge-flap chord (moments taken about leading-edge-flap hinge line)

$c_{m,w'}$ section pitching-moment coefficient of that portion of wing between leading-edge and trailing-edge flaps based on plain-wing chord (moments taken about wing quarter-chord)

$c_{m,w}$ wing section pitching-moment coefficient based on plain-wing chord (moments taken about wing quarter-chord; chord force of leading- and trailing-edge flaps neglected),

$$c_{m,w'} - \frac{c_{N,f}\left(l_f + x_f\right)c_f}{c_w^2} + \frac{c_{N,N}\left(l_N + x_N\right)c_N}{c_w^2}$$

MODEL AND APPARATUS

The model was tested in the Langley 300-MPH 7- by 10-foot tunnel by means of the semispan technique with the ceiling of the tunnel as the reflection plane. The geometric characteristics of the semispan wing used in this investigation are given in figure 1. The wing had 0° of sweep, a taper ratio of 1, an aspect ratio of 3.33, and

NACA 65A004 airfoil sections parallel to the free-stream direction. The wing was equipped with leading-edge and trailing-edge flaps. The leading-edge-flap chord was 15 percent of the wing chord, and the leading-edge flap pivoted about the lower surface along the 15-percent-chord line. (See fig. 2.) For the deflected condition the break in the upper surface was faired to an arc of a circle. The sealed trailing-edge-flap chord was 25 percent of the wing chord. (See fig. 2.) The leading-edge flap, the trailing-edge flap, and the wing were constructed with flush-surface pressure orifices located at the 60-percent-semispan station.

The 10-percent-chord projection spoiler used in this investigation was made of wood to the dimensions shown in figure 2. The spans, spanwise locations, and chordwise locations of the various spoiler arrangements are indicated in figure 2.

TESTS

The tests were made in the Langley 300-MPH 7- by 10-foot tunnel at a dynamic pressure of approximately 25 pounds per square foot. For these tests, the leading-edge flap was deflected at 0° or 30° and the trailing-edge flap was deflected at 0° or 15°. The spoiler had a projection of 10 percent chord and was tested as a full-semispan control, a half-semispan inboard control, and a half-semispan outboard control hinged at the 10-, 30-, 50-, 70-, and 90-percent-chord locations. (See fig. 2.) The maximum angle-of-attack range for this investigation was from about -12° to 24°. Chordwise pressure distributions were obtained at the 60-percent-semispan station.

CORRECTIONS

The jet-boundary corrections applied to the data of this paper were obtained by the method outlined in reference 3 and are as follows:

$$\Delta\alpha = 1.435C_L$$

$$\Delta C_D = 0.025C_L^2$$

The blockage correction as applied to the dynamic pressure was obtained by the method outlined in reference 4.

RESULTS

The results of this investigation are presented without discussion. The order of presentation in the figures and tables is as follows:

Static longitudinal and lateral aerodynamic characteristics:

	Figure
Half-span inboard spoiler; $\delta_N = 0^\circ$; $\delta_f = 0^\circ$	3
Half-span outboard spoiler; $\delta_N = 0^\circ$; $\delta_f = 0^\circ$	4
Full-span spoiler; $\delta_N = 0^\circ$; $\delta_f = 0^\circ$	5
Half-span outboard spoiler; $\delta_N = 0^\circ$ and 30°; $\delta_f = 0^\circ$ and 15°	6
Full-span spoiler; $\delta_N = 0^\circ$ and 30°; $\delta_f = 0^\circ$	7
Lift-curve-slope comparison	8

Chordwise pressure distribution:

Basic model; $\delta_N = 0^\circ$; $\delta_f = 0^\circ$	9
Half-span inboard spoiler; $\delta_N = 0^\circ$; $\delta_f = 0^\circ$	10 to 14
Half-span outboard spoiler; $\delta_N = 0^\circ$; $\delta_f = 0^\circ$	15 to 19
Full-span spoiler; $\delta_N = 0^\circ$; $\delta_f = 0^\circ$	20 to 24
Half-span outboard spoiler; $\delta_N = 30^\circ$; $\delta_f = 0^\circ$ and 15°	25 to 28
Full-span spoiler; $\delta_N = 30^\circ$; $\delta_f = 0^\circ$	29 to 32

Tabulated integrated section data:

	Table
Half-span inboard spoiler; $\delta_N = 0^\circ$; $\delta_f = 0^\circ$	I
Half-span outboard spoiler; $\delta_N = 0^\circ$; $\delta_f = 0^\circ$	II
Full-span spoiler; $\delta_N = 0^\circ$; $\delta_f = 0^\circ$	III
Half-span outboard spoiler; $\delta_N = 30^\circ$; $\delta_f = 0^\circ$ and 15°	IV
Full-span spoiler; $\delta_N = 30^\circ$; $\delta_f = 0^\circ$	V

Since the location of the pressure orifices is at the 60-percent-semispan station, the section data for the full-span and half-span outboard spoilers show the effect of the spoilers on the section loading; whereas the section data for the half-span inboard spoiler give an indication of the carryover of the load outboard of the spoiler. It should also be pointed out that these data are for only one value of spoiler projection and, although they are useful in determining the

effects of the several variables, they are not necessarily applicable to the design of a control surface that uses small deflections.

A method has been developed by the Data Reduction Branch of the Langley Instrument Research Division whereby the IBM type 407 accounting machine can be used to obtain approximate plots of data as they are tabulated. This tabulator was used to obtain the plots of figures 9 to 32, and even though they are not as accurate as may be desired, they do show trends of the pressure distribution. An accurate tabulation of these data is provided at the left of these figures.

Langley Aeronautical Laboratory,
National Advisory Committee for Aeronautics,
Langley Field, Va., January 14, 1958.

REFERENCES

1. Croom, Delwin R., Shufflebarger, C. C., and Huffman, Jarrett K.: An Investigation of Forward-Located Fixed Spoilers and Deflectors as Gust Alleviators on an Unswept-Wing Model. NACA TN 3705, 1956.

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3. Polhamus, Edward C.: Jet-Boundary-Induced-Upwash Velocities for Swept Reflection-Plane Models Mounted Vertically in 7- by 10-Foot, Closed, Rectangular Wind Tunnels. NACA TN 1752, 1948.

4. Herriot, John G.: Blockage Corrections for Three-Dimensional Flow Closed-Throat Wind Tunnels, With Consideration of the Effect of Compressibility. NACA Rep. 995, 1950. (Supersedes NACA RM A7B28.)

TABLE I.- INTEGRATED SECTION DATA

[$\delta_f = 0^\circ$; $\delta_N = 0^\circ$; half-span inboard spoiler]

α, deg	$c_{N,w}$	$c_{m,w}$	$c_{N,N}$	$c_{m,N}$	$c_{N,f}$	$c_{m,f}$
Basic model - spoiler off						
2-	.1091-	.0024	.3427-	.2227-	.0342-	.0110
0	.0038	.0052	.0519	.0329	.0145-	.0061
4-	.2395-	.0026-	.7993-	.5249-	.0514-	.0182
6-	.3922-	.0086-	1.4095-	.8693-	.0764-	.0270
8-	.5096-	.0083-	1.5322-	.8160-	.0776-	.0267
10-	.6423-	.0251	1.4115-	.7502-	.1183-	.0427
11-	.6991-	.0432	1.4301-	.7618-	.1671-	.0613
2	.1044	.0072	.3890	.2507	.0013	.0013-
4	.2495	.0094	.8689	.5560	.0260	.0099-
6	.4062	.0142	1.4597	.9209	.0533	.0194-
8	.5295	.0137	1.7207	.9391	.0634	.0213-
10	.6670	.0172-	1.5635	.8244	.1078	.0387-
12	.7537	.0517-	1.5019	.7933	.1847	.0656-
13	.7697	.0505-	1.5815	.8387	.2024	.0726-
14	.8182	.0508-	1.7077	.9018	.2124	.0786-
15	.8471	.0576-	1.7464	.9213	.2329	.0850-
16	.8872	.0714-	1.7735	.9347	.2772	.1027-
17	.9327	.0868-	1.7993	.9444	.3332	.1264-
18	.9064	.1161-	1.5628	.8249	.4369	.1731-
Spoiler hinged at 0.1c						
4-	.1986-	.0291-	.8939-	1.3778-	.0260-	.2301
0	.0214	.0350-	.1859-	.4427-	.0411	.0690
4	.2472	.0421-	.5762	.5400	.1380	.1646-
6	.3502	.0468-	.9368	1.0031	.1974	.3123-
8	.4383	.0482-	1.2587	1.4222	.2409	.4197-
10	.6010	.0460-	1.9757	2.1107	.2727	.5024-
12	.7182	.0510-	2.3177	2.4800	.3052	.5827-
14	.8074	.0654-	2.1735	2.3231	.3079	.5910-
16	.7860	.0990-	1.6369	1.7467	.3718	.7456-
18	.8747	.1269-	1.6814	1.7973	.4734	.9939-
Spoiler hinged at 0.3c						
4-	.2692-	.0411-	1.2133-	.7849-	.0279	.0074-
0	.0423-	.0385-	.4047-	.2493-	.0927	.0331-
4	.1581	.0321-	.3357	.2316	.1427	.0533-
6	.2720	.0299-	.7275	.4800	.1666	.0637-
8	.3987	.0286-	1.1580	.7196	.1835	.0683-
10	.5633	.0284-	1.4916	.8151	.1651	.0608-
12	.6954	.0325-	1.5744	.8356	.1763	.0670-
14	.8217	.0898-	1.4181	.7498	.2960	.1072-
16	.8298	.1193-	1.3338	.7084	.4378	.1731-
18	.7978	.1171-	1.2939	.6889	.4438	.1779-

α, deg	$c_{N,w}$	$c_{m,w}$	$c_{N,N}$	$c_{m,N}$	$c_{N,f}$	$c_{m,f}$
Spoiler hinged at 0.5c						
4-	.3666-	.0250-	1.3151-	.8396-	.0296	.0150-
0	.1200-	.0162-	.3921-	.2404-	.0748	.0366-
4	.1163	.0088-	.4422	.2969	.1125	.0470-
6	.2258	.0038-	.8353	.5498	.1257	.0512-
8	.3756	.0020-	1.3685	.8107	.1447	.0574-
10	.5769	.0266-	1.4029	.7538	.1509	.0547-
12	.7309	.0850-	1.2423	.6649	.2729	.0989-
14	.8171	.1055-	1.3373	.7147	.3488	.1315-
16	.8083	.1177-	1.3080	.6991	.4408	.1758-
18	.8028	.1170-	1.3200	.7053	.4487	.1832-
Spoiler hinged at 0.7c						
4-	.4188-	.0013	1.3030-	.8333-	.1559-	.5339
0	.1562-	.0117	.3218-	.1951-	.1137-	.4170
4	.0893	.0192	.5364	.3547	.0840-	.3469
6	.2254	.0200	.9781	.6458	.0596-	.2806
8	.3567	.0202	1.4287	.8493	.0376-	.2227
10	.5520	.0131-	1.3880	.7440	.0054	.1112
12	.7508	.0694-	1.3633	.7253	.0792	.0646-
14	.8499	.1169-	1.3379	.7138	.2097	.3890-
16	.8554	.1257-	1.3576	.7253	.2753	.5496-
18	.8186	.1208-	1.3277	.7098	.2842	.5701-
Spoiler hinged at 0.9c						
4-	.5088-	.0446	1.3630-	.8644-	.2802-	.1643
0	.2350-	.0516	.3811-	.2351-	.2312-	.1461
4	.0355	.0546	.5271	.3489	.1751-	.1224
6	.1785	.0569	.9985	.6569	.1494-	.1139
8	.3390	.0558	1.5475	.9289	.1090-	.0994
10	.5120	.0248	1.4831	.7871	.0403-	.0717
12	.6764	.0205-	1.4764	.7836	.0604	.0370
14	.7855	.0451-	1.5930	.8444	.1332	.0133
16	.8423	.0777-	1.5463	.8191	.2423	.0222-
18	.7948	.1000-	1.3294	.7093	.3386	.0587-

TABLE II.- INTEGRATED SECTION DATA

[$\delta_f = 0^o$; $\delta_N = 0^o$; half-span outboard spoiler]

α, deg	$c_{N,w}$	$c_{m,w}$	$c_{N,N}$	$c_{m,N}$	$c_{N,f}$	$c_{m,f}$
Spoiler hinged at 0.1c						
4-	.1448-	.0768-	1.7707-	2.2249-	.0410-	.2648
0	.0361	.0948-	1.2086-	1.5929-	.0826	.0309-
4	.2443	.1149-	.5915-	.7422-	.2345	.4067-
6	.3569	.1310-	.3367-	.3973-	.3231	.6211-
8	.4301	.1298-	.0005-	.0000	.3640	.7250-
10	.5429	.1293-	.4409	.5191	.3894	.7877-
12	.7164	.1208-	1.2129	1.3324	.3913	.7966-
14	.7736	.1205-	1.3771	1.4547	.4065	.8270-
16	.7560	.1243-	1.3663	1.4560	.4603	.9616-
18	.8186	.1267-	1.5646	1.6751	.4834	1.0178-
Spoiler hinged at 0.3c						
4-	.2020-	.1266-	1.4508-	.8511-	.2705	.0973-
0	.0688-	.1036-	.6825-	.4018-	.2970	.1165-
4	.1019	.0875-	.0708	.1022	.3328	.1371-
6	.2013	.0821-	.4066	.3196	.3326	.1355-
8	.3757	.0849-	.9231	.6538	.3834	.1547-
10	.6044	.0868-	1.4626	.9476	.4045	.1616-
12	.7747	.1018-	1.2611	.6724	.3398	.1301-
14	.7886	.1022-	1.2834	.6778	.3456	.1325-
16	.7615	.1161-	1.1935	.6356	.4246	.1648-
18	.7789	.1213-	1.2287	.6591	.4569	.1854-
Spoiler hinged at 0.5c						
4-	.3591-	.0744-	1.3183-	.8124-	.3311	.1410-
0	.1931-	.0433-	.4706-	.2813-	.3021	.1344-
4	.0117-	.0125-	.3320	.2387	.2398	.1072-
6	.1084	.0093-	.7464	.5053	.2524	.1126-
8	.2990	.0166-	1.3250	.8436	.3120	.1365-
10	.5268	.0387-	1.6475	.8991	.3895	.1654-
12	.7660	.0903-	1.4249	.7533	.4250	.1808-
14	.7806	.0988-	1.3589	.7227	.4024	.1621-
16	.8050	.1054-	1.3528	.7231	.3902	.1563-
18	.7918	.1085-	1.3248	.7076	.4147	.1667-

α, deg	$c_{N,w}$	$c_{m,w}$	$c_{N,N}$	$c_{m,N}$	$c_{N,f}$	$c_{m,f}$
Spoiler hinged at 0.7c						
4-	.5034-	.0163	1.2387-	.7867-	.1850	.3160-
0	.2682-	.0307	.3355-	.2027-	.1742	.2939-
4	.0508-	.0501	.4857	.3258	.0888	.0870-
6	.0792	.0514	.9096	.6027	.0845	.0794-
8	.2591	.0467	1.4967	.9244	.1041	.1286-
10	.5080	.0027	1.5429	.8236	.1834	.3280-
12	.6777	.0413-	1.4734	.7804	.1994	.3741-
14	.7560	.0762-	1.4353	.7604	.2305	.4531-
16	.8141	.0744-	1.6515	.8738	.2818	.5786-
18	.8336	.1086-	1.4329	.7591	.2540	.5064-
Spoiler hinged at 0.9c						
4-	.7000-	.1707	1.2536-	.7898-	.9415-	.5192
0	.4377-	.1803	.2961-	.1822-	.9131-	.5165
4	.1591-	.1688	.5549	.3640	.7641-	.4371
6	.0050	.1624	1.0717	.7071	.6802-	.3957
8	.1805	.1435	1.5870	.9680	.5416-	.3318
10	.3700	.0993	1.5115	.8093	.4000-	.2661
12	.5770	.0422	1.5084	.7978	.2444-	.2038
14	.6575	.0050-	1.4708	.7804	.0595-	.1152
16	.7293	.0222-	1.5767	.8360	.0344	.0662
18	.8276	.0541-	1.6557	.8729	.1491	.0238

TABLE III.- INTEGRATED SECTION DATA

[$\delta_f = 0^\circ$; $\delta_N = 0^\circ$; full-span spoiler]

α, deg	$c_{N,w}$	$c_{m,w}$	$c_{N,N}$	$c_{m,N}$	$c_{N,f}$	$c_{m,f}$
Spoiler hinged at 0.1c						
4-	.2519-	.1156-	1.8637-	2.3307-	.2106	.3387-
0	.0365-	.1286-	1.6296-	2.1067-	.2656	.4685-
4	.1342	.1257-	.9891-	1.2711-	.3056	.5675-
6	.1932	.1240-	.7737-	.9796-	.3213	.6061-
8	.2520	.1192-	.5309-	.6484-	.3262	.6200-
10	.3117	.1144-	.2781-	.3271-	.3260	.6203-
12	.4639	.1108-	.3825	.3800	.3612	.7090-
14	.5736	.1084-	.8497	.8720	.3826	.7662-
16	.7145	.1115-	1.3749	1.4542	.4277	.8821-
18	.8571	.1151-	1.8859	2.0187	.4708	.9941-
Spoiler hinged at 0.3c						
4-	.4900-	.0855-	1.8967-	.9840-	.1379	.0555-
0	.2769-	.0803-	1.1927-	.7151-	.1809	.0757-
4	.0428-	.0847-	.3905-	.1880-	.2658	.1136-
6	.0468	.0823-	.0745-	.0200	.2836	.1202-
8	.1561	.0791-	.2797	.2498	.2976	.1264-
10	.3268	.0805-	.7309	.4916	.3422	.1446-
12	.6310	.0910-	1.1993	.6600	.3744	.1518-
14	.7551	.1039-	1.2443	.6618	.3725	.1494-
16	.8251	.1110-	1.3549	.7084	.4090	.1608-
18	.8360	.1185-	1.3755	.7244	.4524	.1803-
Spoiler hinged at 0.5c						
4-	.6092-	.0413-	1.9362-	1.0764-	.1519	.0622-
0	.3887-	.0160-	.8769-	.5267-	.1564	.0682-
4	.1486-	.0129-	.0542-	.0004	.2156	.0926-
6	.0272-	.0131-	.3427	.2569	.2392	.1042-
8	.0875	.0111-	.7131	.4996	.2545	.1106-
10	.2785	.0143-	1.1367	.6667	.2439	.1075-
12	.6782	.0775-	1.2814	.6844	.3632	.1514-
14	.8035	.0951-	1.3963	.7391	.3671	.1458-
16	.8437	.1052-	1.4057	.7440	.3857	.1523-
18	.8286	.1094-	1.3943	.7396	.4159	.1672-

α, deg	$c_{N,w}$	$c_{m,w}$	$c_{N,N}$	$c_{m,N}$	$c_{N,f}$	$c_{m,f}$
Spoiler hinged at 0.7c						
4-	.7143-	.0373	1.7953-	1.0147-	.0744	.0203-
2-	.5638-	.0404	1.1917-	.7587-	.1060	.1058-
0	.4317-	.0509	.6656-	.4071-	.0909	.0725-
4	.1962-	.0585	.1573	.1231	.0905	.0781-
6	.0837-	.0586	.5098	.3484	.0876	.0738-
8	.0606	.0615	.9897	.6631	.0707	.0382-
10	.2804	.0384	1.3759	.7738	.0654	.0326-
12	.5134	.0001	1.4168	.7520	.1524	.2534-
14	.7874	.0741-	1.4919	.7902	.2306	.4552-
16	.8557	.1092-	1.4410	.7640	.2628	.5299-
18	.8444	.1172-	1.3867	.7382	.2380	.4630-
Spoiler hinged at 0.9c						
0	.6646-	.2140	.7169-	.4409-	1.0500-	.5690
2-	.8038-	.2123	1.2252-	.7796-	1.0942-	.5962
4-	.9462-	.2049	1.8439-	1.0573-	1.1068-	.5986
6-	1.1210-	.2108	1.8867-	.9849-	1.1150-	.6010
8-	1.3066-	.2454	1.9075-	.9991-	1.1435-	.6154
10-	1.3434-	.2888	1.7431-	.9151-	1.2542-	.6509
12-	1.3203-	.3175	1.5562-	.8213-	1.3704-	.7000
2	.5294-	.2159	.2735-	.1560-	1.0242-	.5683
4	.3756-	.2057	.1755	.1316	.9261-	.5149
6	.2287-	.1992	.6179	.4138	.8512-	.4771
8	.0405-	.1804	1.1305	.7409	.7190-	.4155
10	.1991	.1360	1.5102	.8351	.4974-	.3107
12	.4888	.0528	1.3829	.7342	.2702-	.2090
14	.6557	.0059-	1.4777	.7853	.0422-	.1075
16	.7376	.0350-	1.5330	.8133	.0854	.0430
18	.7925	.0895-	1.3898	.7387	.2938	.0482-

TABLE IV.- INTEGRATED SECTION DATA

[Half-span outboard spoiler]

α, deg	$c_{N,w}$	$c_{m,w}$	$c_{N,N}$	$c_{m,N}$	$c_{N,f}$	$c_{m,f}$
$\delta_f = 0^o$; $\delta_N = 30^o$; Spoiler hinged at 0.5c						
8-	.6978-	.0459	1.3540-	.7520-	.0266-	.0040
4-	.5683-	.0021	1.2277-	.7049-	.1969	.1205-
0	.3673-	.0500-	1.0283-	.6218-	.3680	.1818-
4	.1570-	.0609-	.6502-	.4516-	.3095	.1400-
8	.1382	.0681-	.1838-	.2253-	.2813	.1227-
12	.4757	.0858-	.6387	.1244	.3776	.1600-
16	.7348	.0873-	1.6431	.7351	.4935	.2155-
20	.9780	.1290-	1.8637	.9587	.5595	.2365-
24	1.1249	.1256-	2.5341	1.3862	.5646	.2344-
$\delta_f = 0^o$; $\delta_N = 30^o$; Spoiler hinged at 0.7c						
8-	.8486-	.1374	1.3517-	.7556-	.2552-	.8328
4-	.7021-	.0878	1.2244-	.7138-	.0152-	.1947
0	.4452-	.0192	.9723-	.6058-	.2144	.4077-
4	.1675-	.0055-	.5233-	.3991-	.1678	.2955-
8	.0970	.0045-	.0187-	.1578-	.1098	.1546-
12	.3912	.0053-	.9069	.2480	.1752	.3166-
16	.7183	.0274-	1.9324	.8747	.3408	.7386-
20	.9141	.0527-	2.4967	1.2960	.3929	.8733-
24	1.1290	.1191-	2.5981	1.4058	.4125	.9272-

α, deg	$c_{N,w}$	$c_{m,w}$	$c_{N,N}$	$c_{m,N}$	$c_{N,f}$	$c_{m,f}$
$\delta_f = 0^o$; $\delta_N = 30^o$; Spoiler hinged at 0.9c						
8-	1.0401-	.2850	1.3653-	.7649-	1.2942-	.6688
4-	.8989-	.2357	1.2582-	.7333-	1.0374-	.5344
0	.6076-	.1553	.9682-	.6058-	.7459-	.4118
4	.2881-	.1083	.5305-	.4053-	.6578-	.3802
8	.0100	.0951	.0081-	.1587-	.6026-	.3584
12	.3383	.0994	1.1094	.3569	.5312-	.3334
16	.6099	.0888	2.0063	.9173	.4070-	.2770
20	.8331	.0468	2.6060	1.3618	.1514-	.1622
24	1.0778	.0777-	2.6108	1.4133	.3096	.0434-
$\delta_f = 15^o$; $\delta_N = 30^o$; spoiler hinged at 0.5c						
8-	.7348-	.0502	1.4017-	.7756-	.0224-	.0162-
4-	.5090-	.0086-	1.1565-	.6756-	.2459	.1331-
0	.2545-	.0540-	.8128-	.5187-	.3804	.1808-
4	.0900	.1205-	.4054-	.3307-	.5376	.2206-
8	.4631	.1487-	.1428	.1213-	.6300	.2498-
12	.7678	.1635-	1.0343	.3653	.7182	.2883-
16	1.0250	.1652-	2.0402	.9787	.8099	.3309-
20	1.2239	.1926-	2.4779	1.3480	.9000	.3642-

TABLE V.- INTEGRATED SECTION DATA

[$\delta_f = 0^o$; $\delta_N = 30^o$; full-span spoiler]

α, deg	$c_{N,w}$	$c_{m,w}$	$c_{N,N}$	$c_{m,N}$	$c_{N,f}$	$c_{m,f}$
$\delta_f = 0^o$; $\delta_N = 30^o$; spoiler hinged at 0.5c						
-8	-.7786	-.0498	-1.5083	-.8213	-.0638	-.0202
-4	-.7859	-.0516	-1.4745	-.8173	-.0173	-.0118
0	-.6736	-.0016	-1.4081	-.7929	.1967	-.0918
4	-.3553	-.0469	-1.0372	-.6271	.2298	-.0950
8	-.0007	-.0787	-.4859	-.3729	.3258	-.1384
12	.3476	-.0823	-.1959	-.1062	.3463	-.1502
16	.6142	-.0913	-.9073	.3307	.3900	-.1646
20	.9170	-.1066	-1.7600	.8920	.4534	-.1898
24	-1.1923	-.1273	-2.6818	-1.4502	.5694	-.2341
$\delta_f = 0^o$; $\delta_N = 30^o$; spoiler hinged at 0.7c						
-8	-.9610	-.1508	-1.4995	-.8209	-.2570	-.8608
-4	-.8851	-.1245	-1.4170	-.7904	-.1174	-.4862
0	-.7076	-.0523	-1.3205	-.7609	-.1159	-.1413
4	-.3562	-.0067	-.8892	-.5667	-.1352	-.2008
8	-.0468	-.0020	-.2685	-.2724	-.1478	-.2378
12	.2327	-.0070	.5467	.0520	-.1518	-.2499
14	.3785	-.0079	.9005	.2622	-.1915	-.3514
16	.5614	-.0311	1.2695	.5058	.2394	-.4760
20	.8500	-.0258	2.5009	1.3013	.2660	-.5544
24	-1.2077	-.1257	-2.7442	-1.4800	.4258	-.9587

α, deg	$c_{N,w}$	$c_{m,w}$	$c_{N,N}$	$c_{m,N}$	$c_{N,f}$	$c_{m,f}$
$\delta_f = 0^o$; $\delta_N = 30^o$; spoiler hinged at 0.9c						
-8	-1.1082	-.3024	-1.4230	-.7867	-1.3601	-.6995
-4	-1.0306	-.2697	-1.3434	-.7640	-1.1475	-.5856
0	-.8402	-.1899	-1.2611	-.7396	-.8584	-.4747
4	-.4894	-.1407	-.8295	-.5449	-.7894	-.4462
8	-.1750	-.1238	-.2295	-.2582	-.7422	-.4270
12	.1298	-.1317	.6733	.1111	-.6721	-.4006
16	.4567	-.1059	1.6207	.6916	-.4965	-.3254
20	.7884	-.0648	2.5777	1.3431	-.2260	-.1955
24	-1.1292	-.0770	-2.7359	-1.4711	-.3024	-.0381
$\delta_f = 0^o$; $\delta_N = 30^o$; Spoiler reversed and hinged at 0.9c						
-8	-1.0370	-.1622	-1.5502	-.8418	-.2515	-.8501
-4	-.9868	-.1430	-1.4938	-.8298	-.1467	-.5634
0	-.8333	-.0738	-1.4259	-.8044	-.0802	-.0462
4	-.4905	-.0265	-1.0272	-.6284	-.0993	-.1050
8	-.1564	-.0073	-.4465	-.3582	-.1274	-.1814
12	-.1697	-.0016	-.3411	-.0409	-.1314	-.1979
16	-.5934	-.0508	-1.0517	-.4173	-.2066	-.3984
20	-.8915	-.0876	-1.9063	-.9858	-.3332	-.7192
24	-1.1531	-.1177	-2.5981	-1.4000	-.3793	-.8398

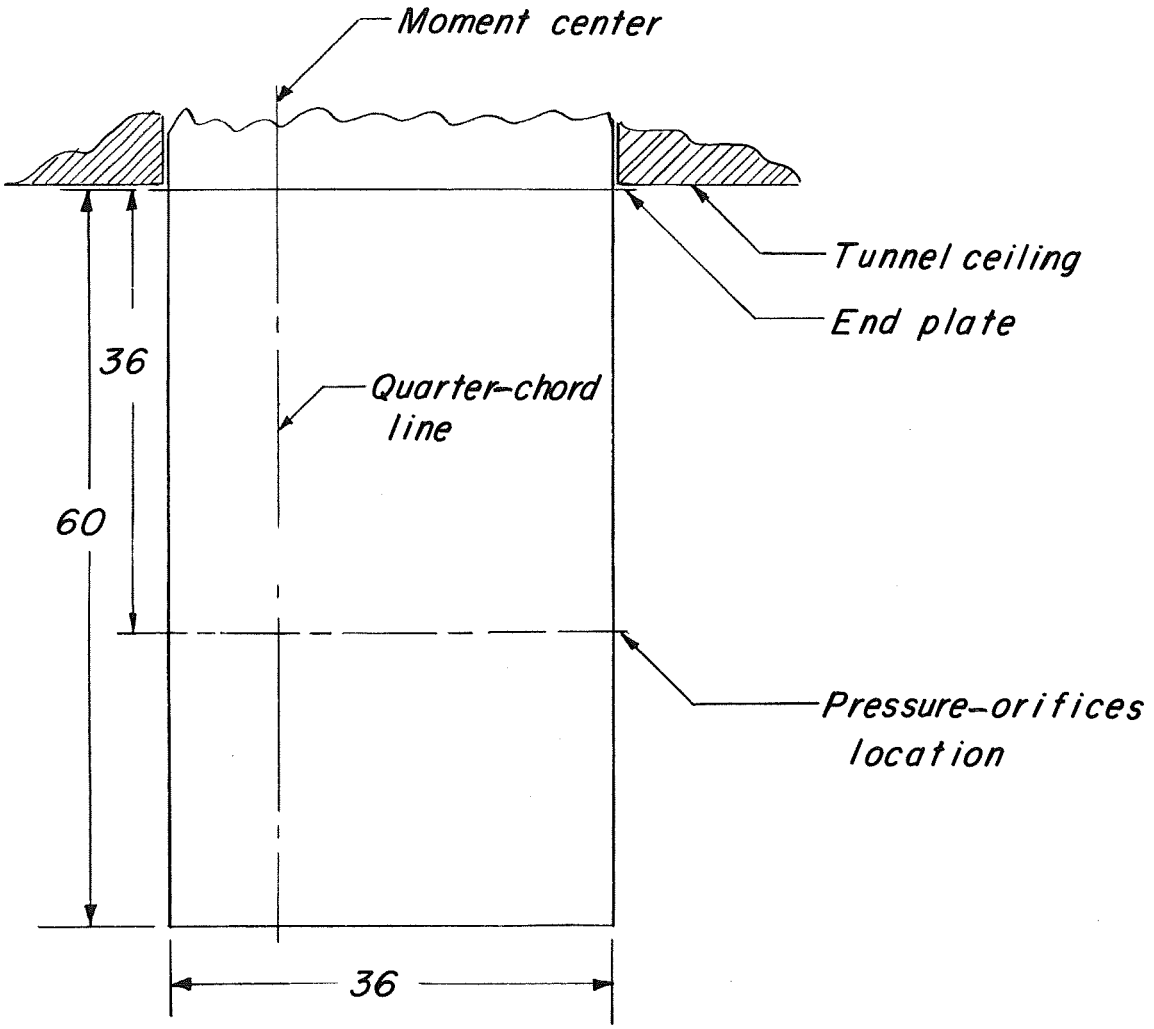


Figure 1.- General characteristics of model. All dimensions are in inches unless otherwise noted.

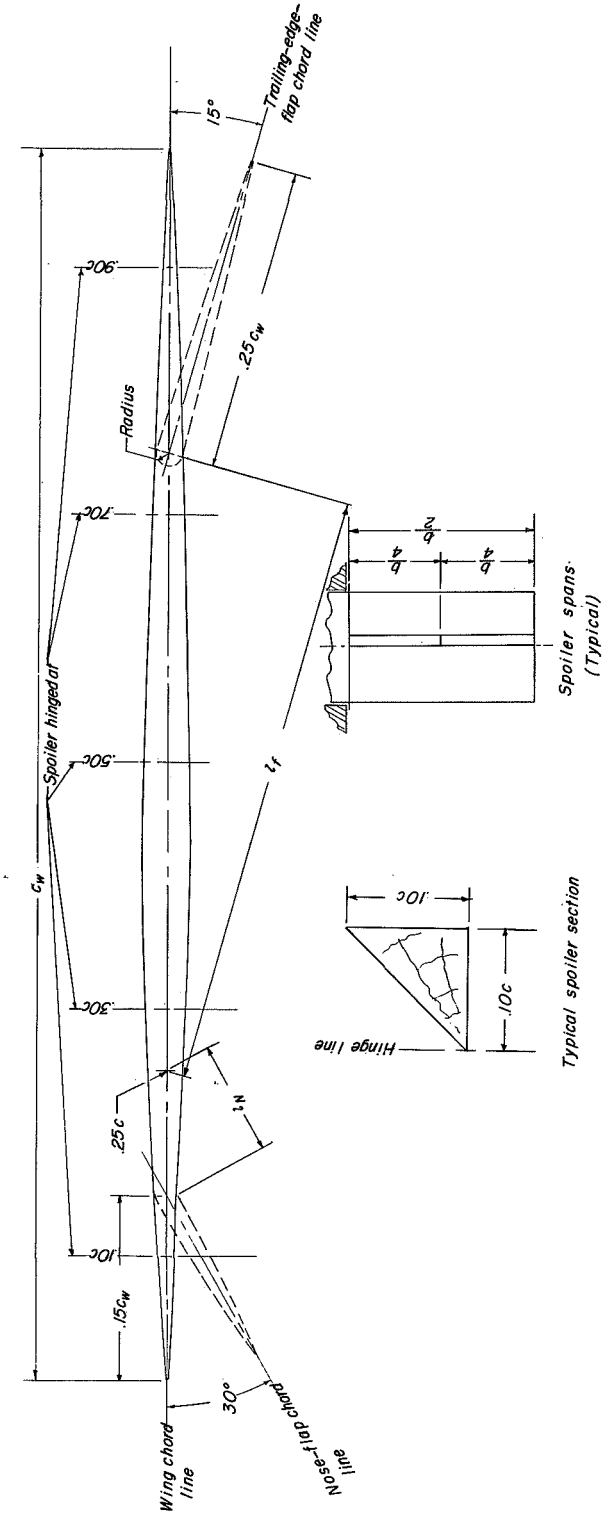
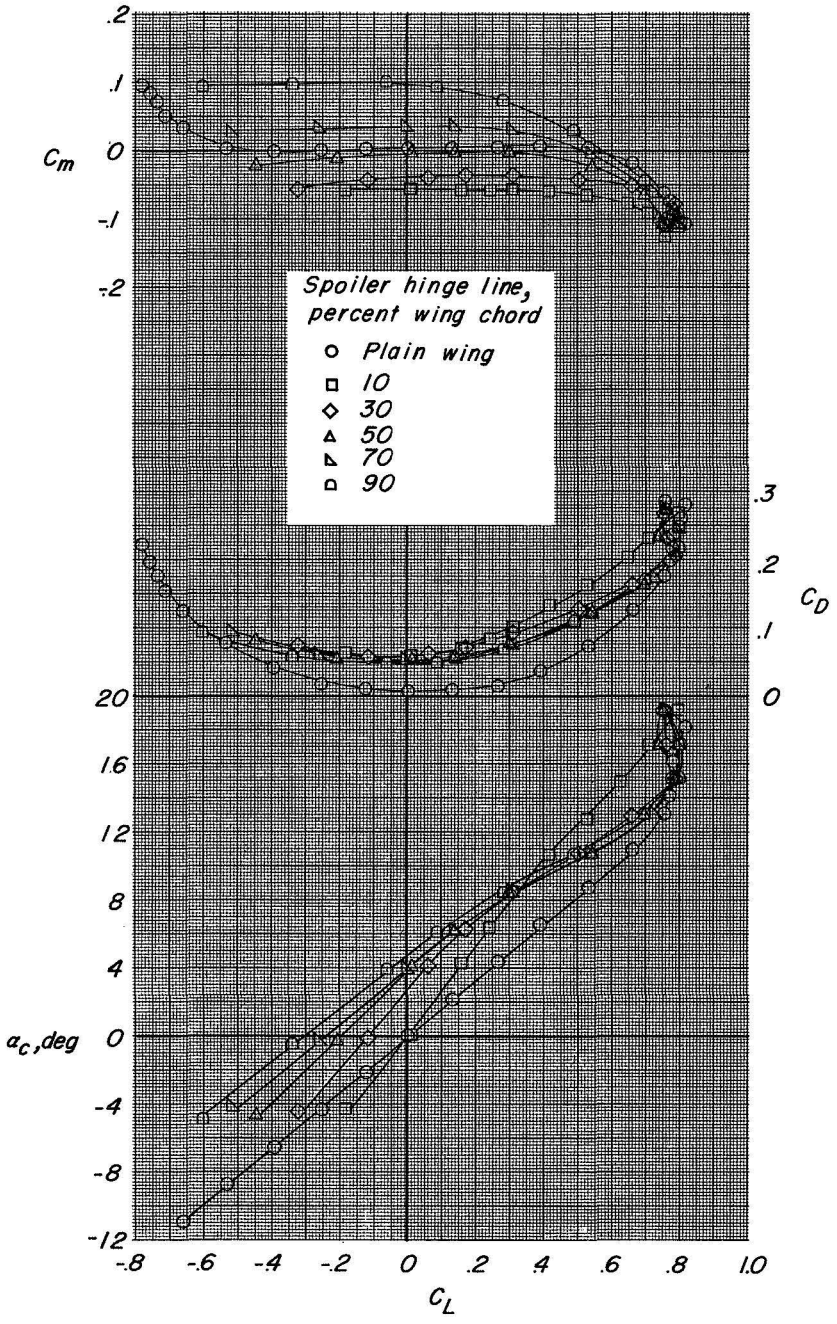
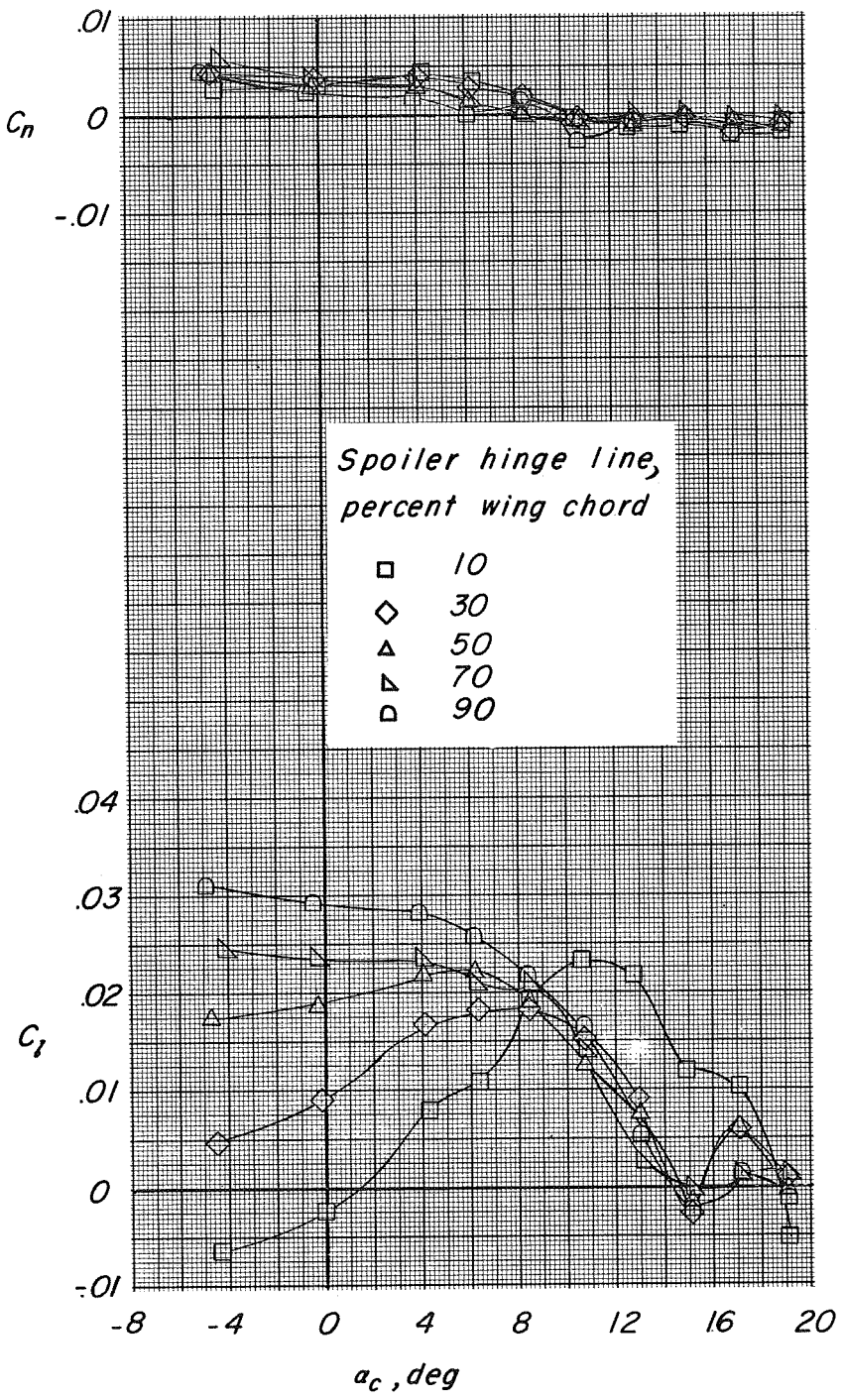


Figure 2.- Details of leading-edge flaps, trailing-edge flaps, and spoiler controls on the model.



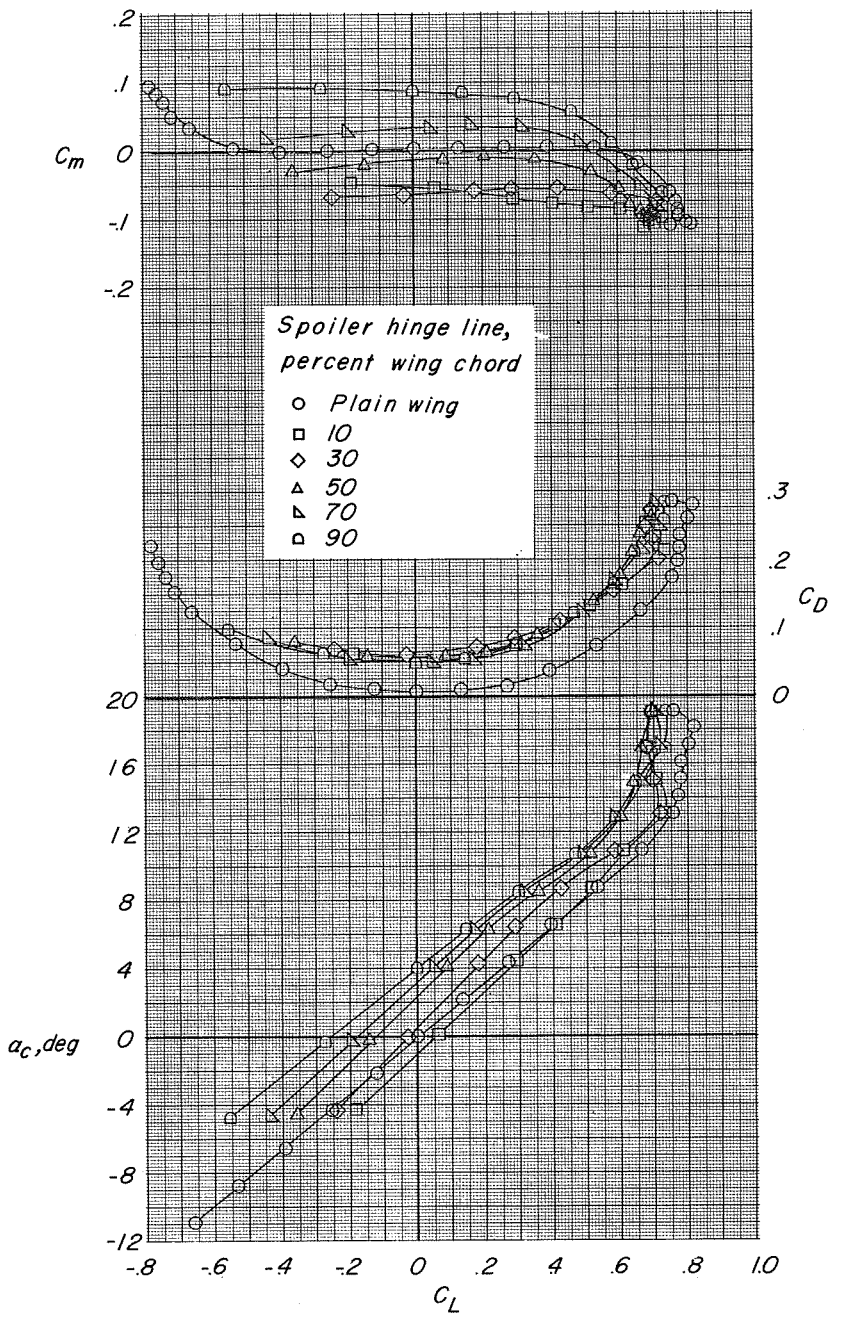
(a) C_m, C_D, and α_c plotted against C_L.

Figure 3.- Effect of chordwise location of half-span inboard spoiler on the aerodynamic characteristics of the semispan model. $\delta_N = 0^\circ$; $\delta_f = 0^\circ$.



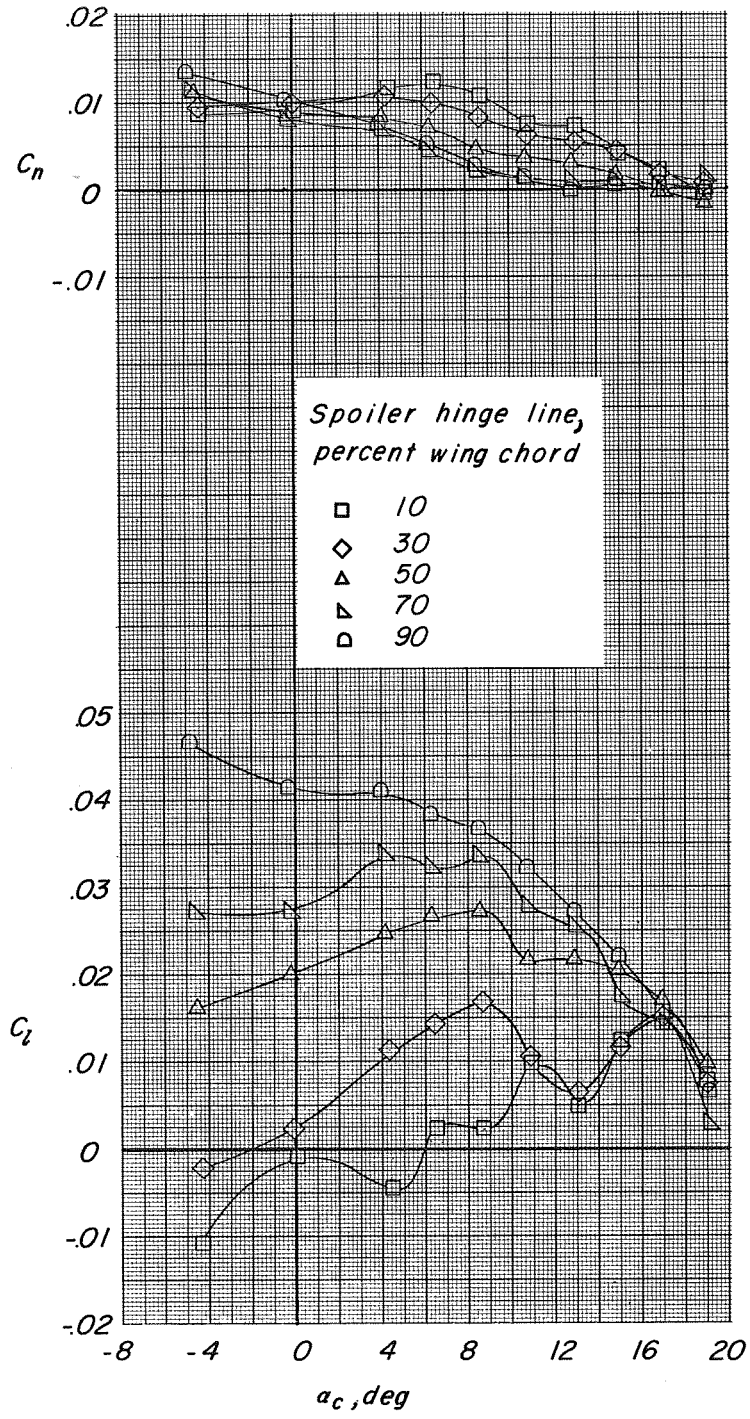
(b) C_n and C_l plotted against α_c.

Figure 3.- Concluded.



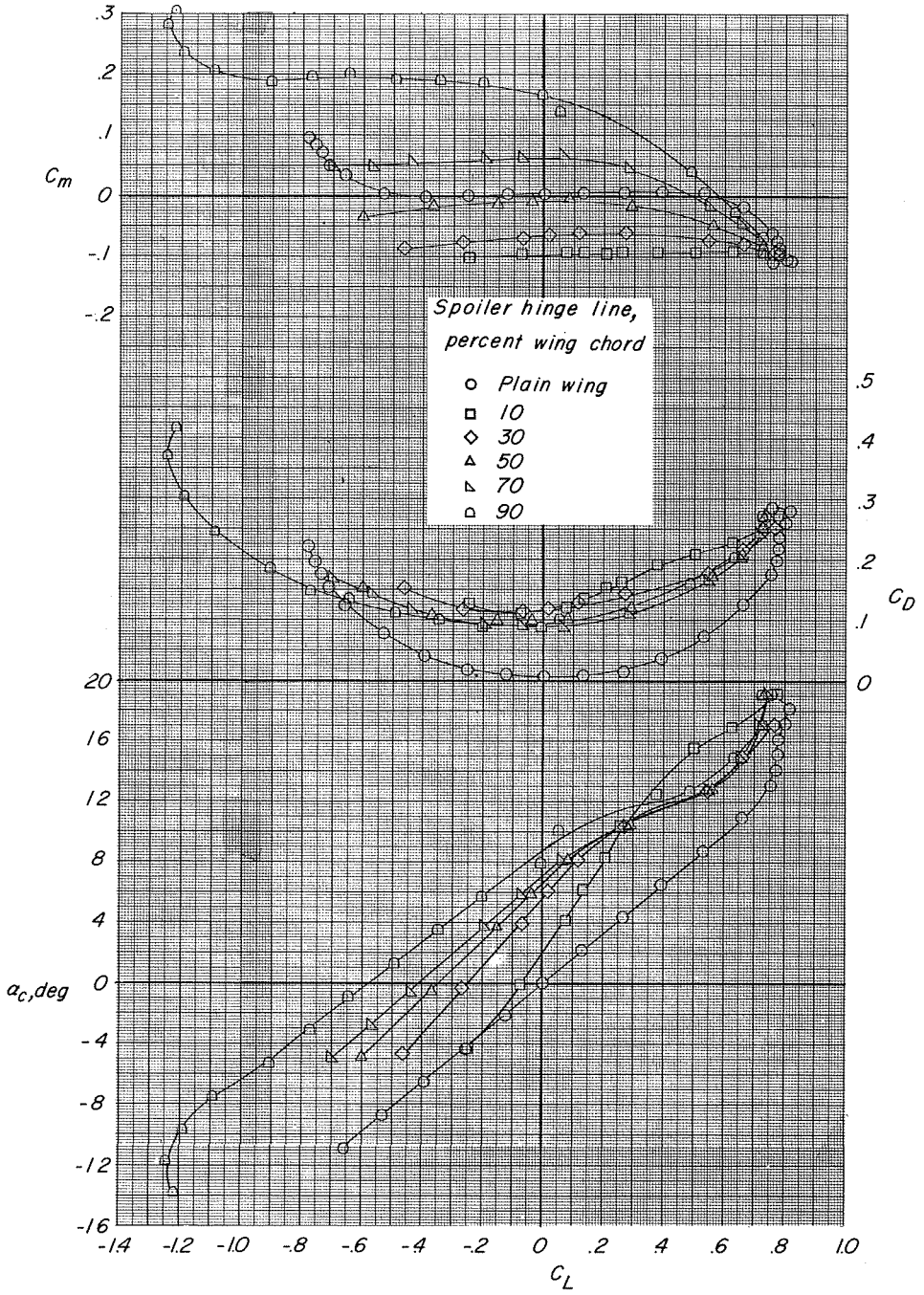
(a) C_m, C_D, and α_c plotted against C_L.

Figure 4.- Effect of chordwise location of half-span outboard spoiler on the aerodynamic characteristics of the semispan model. $\delta_N = 0^\circ$; $\delta_f = 0^\circ$.



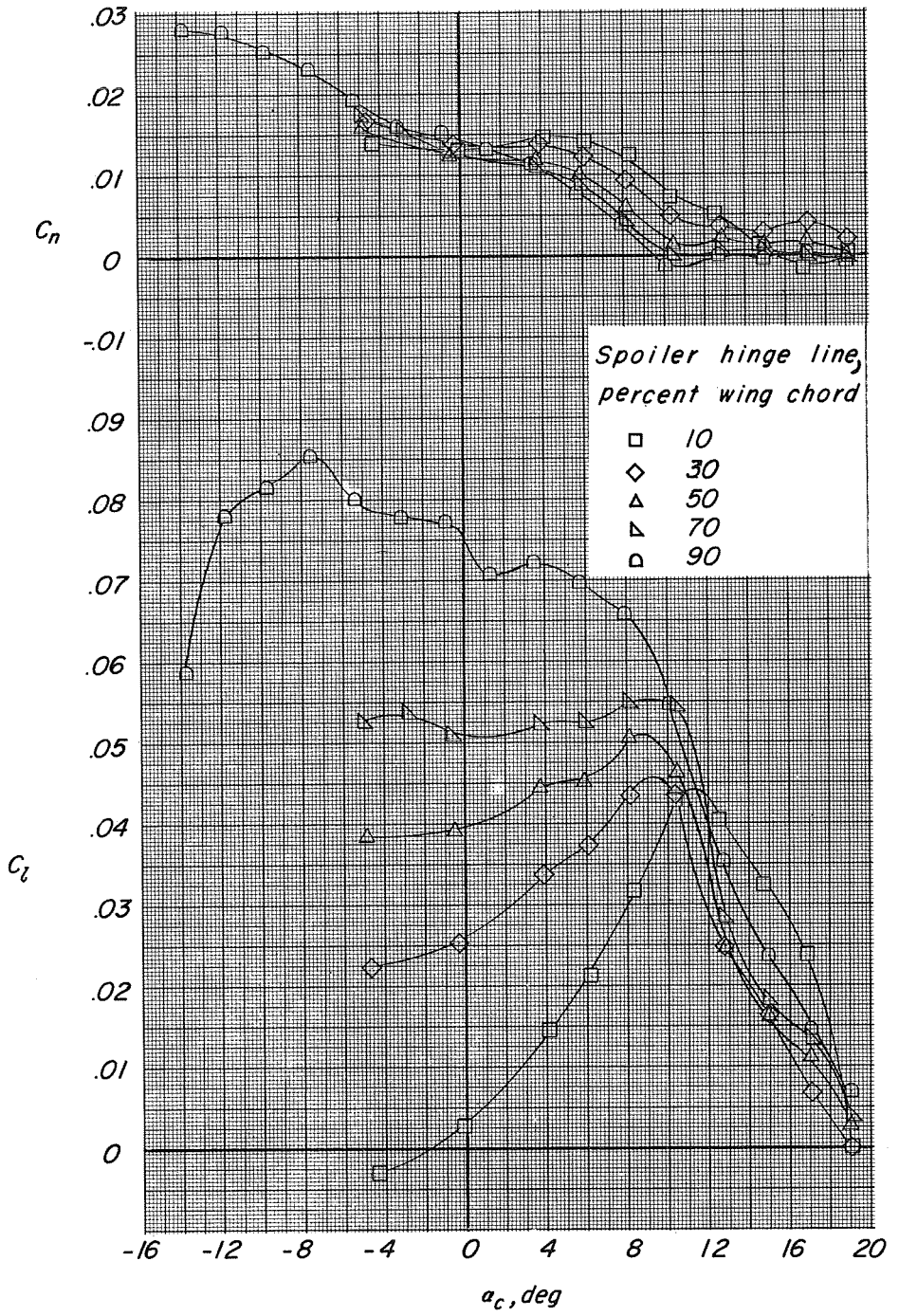
(b) C_n and C_l plotted against α_c.

Figure 4.- Concluded.



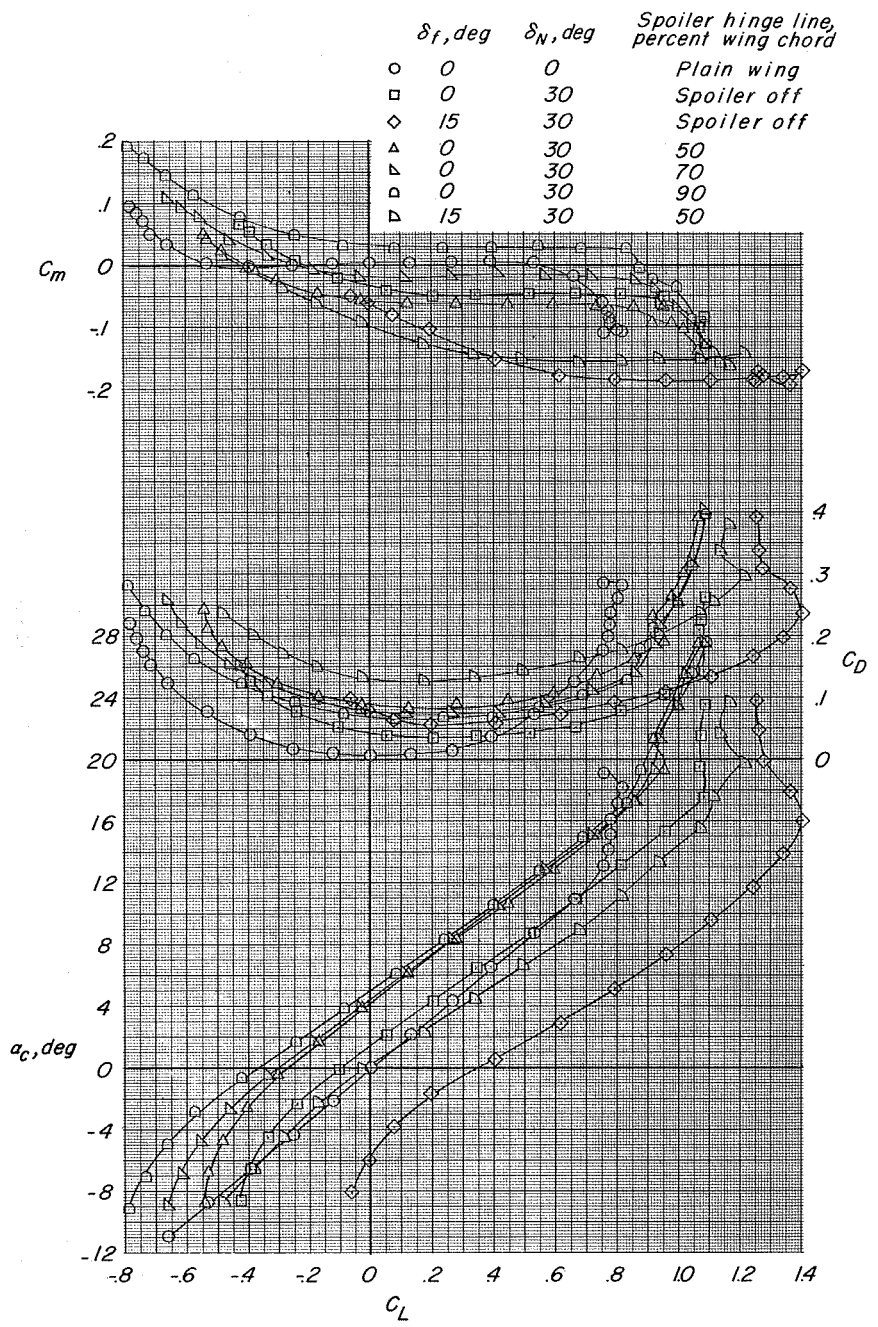
(a) C_m, C_D, and α_c plotted against C_L.

Figure 5.- Effect of chordwise location of full-span spoiler on the aerodynamic characteristics of the semispan model. $\delta_N = 0^o$; $\delta_f = 0^o$.



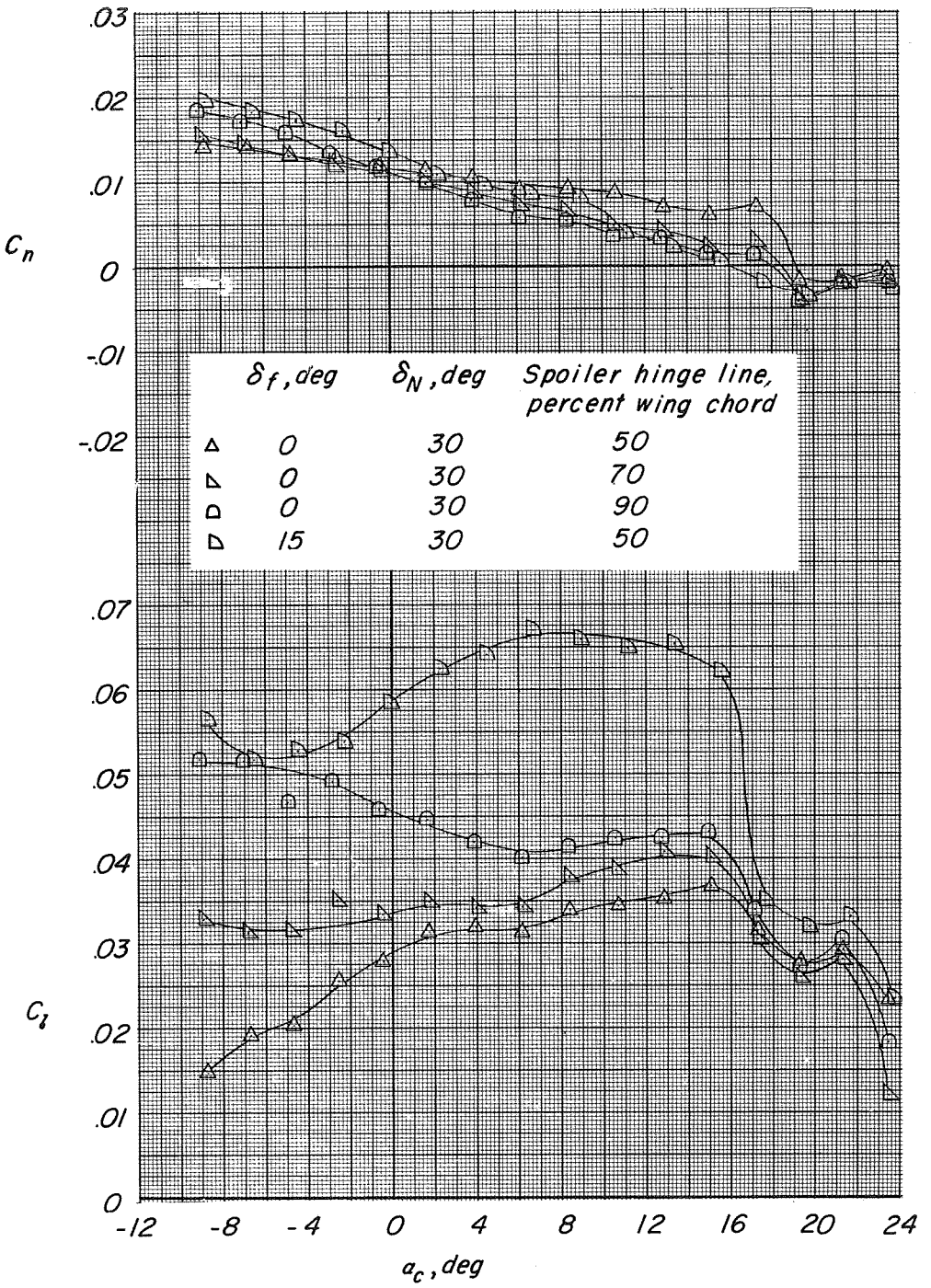
(b) C_n and C_l plotted against α_c.

Figure 5.- Concluded.



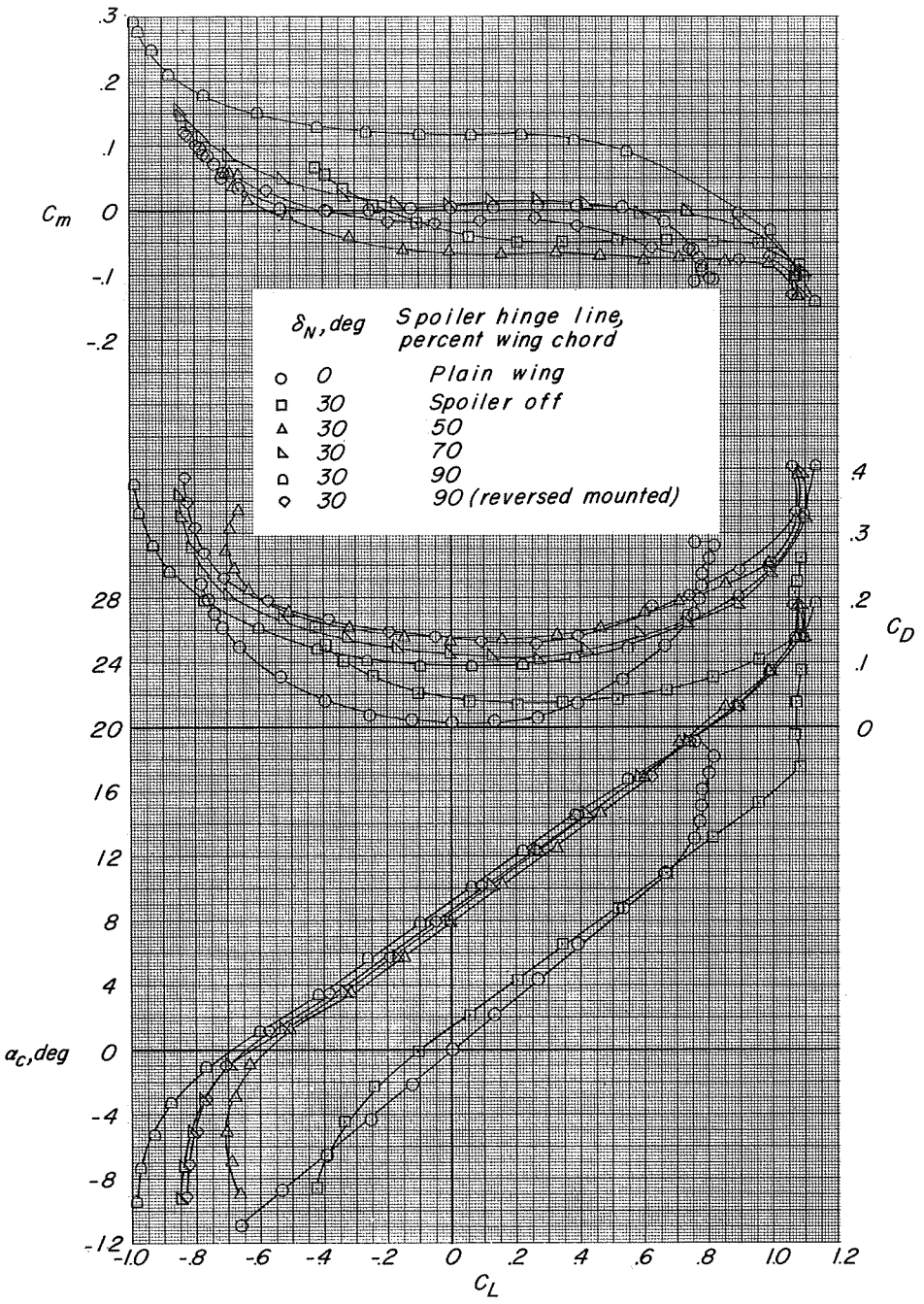
(a) C_m, C_D, and α_c plotted against C_L.

Figure 6.- Effect of chordwise location of half-span outboard spoiler and effect of trailing-edge-flap deflection on the aerodynamic characteristics of the semispan model.



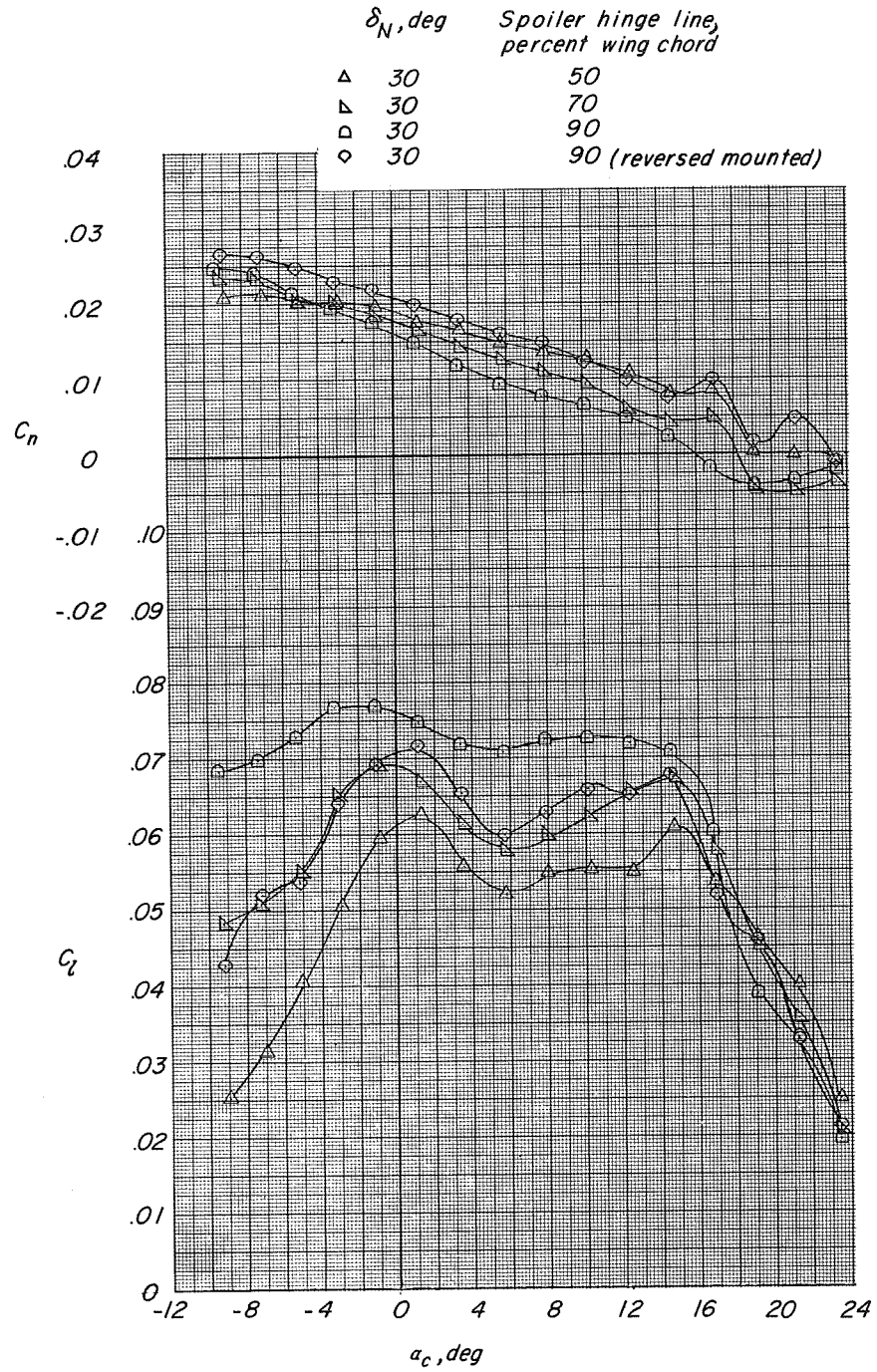
(b) C_n and C_l plotted against α_c.

Figure 6.- Concluded.



(a) C_m, C_D, and α_c plotted against C_L.

Figure 7.- Effect of chordwise location of full-span spoiler and effect of nose-flap deflection on the aerodynamic characteristics of the semispan model. $\delta_f = 0^o$.



(b) C_n and C_l plotted against α_c.

Figure 7.- Concluded.

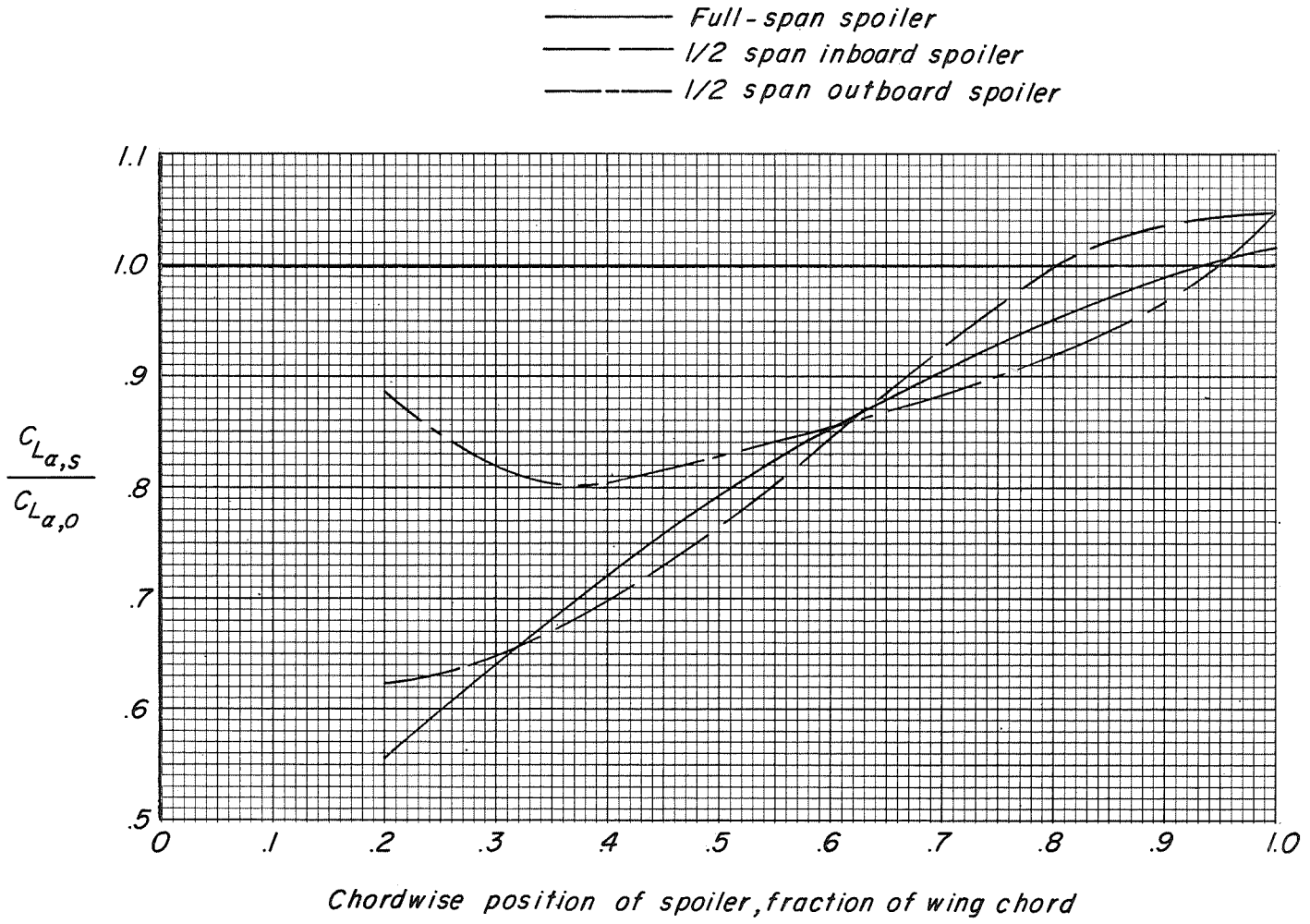
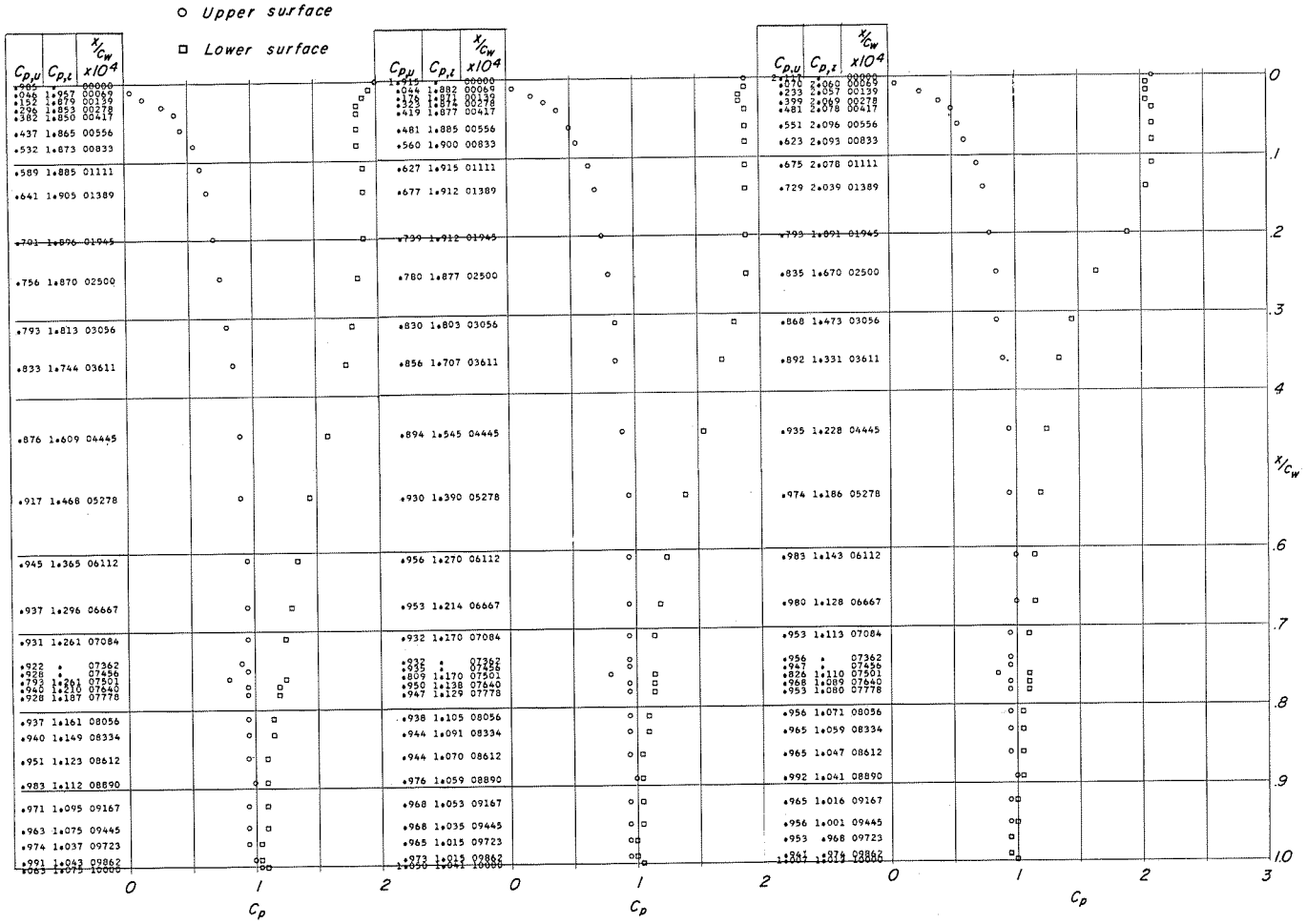
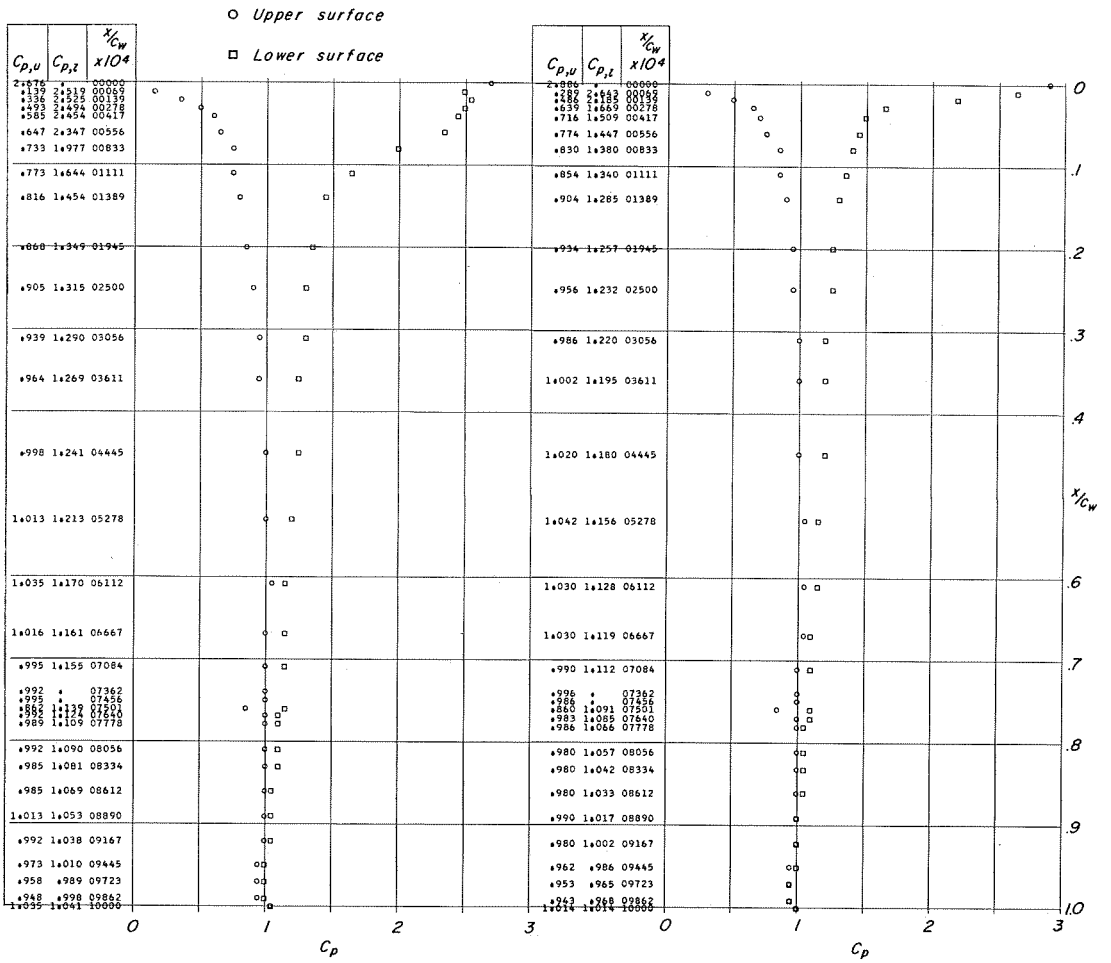


Figure 8.- Variation of lift-curve-slope reduction (measured at $\alpha_c = 0^\circ$) with chordwise location of the full-span, half-span inboard, and half-span outboard spoilers. $\delta_N = 0^\circ$; $\delta_f = 0^\circ$; chordwise location of spoiler is 10 percent chord to the rear of hinge line.



(a) $\alpha = -11^\circ$. (b) $\alpha = -10^\circ$. (c) $\alpha = -8^\circ$.

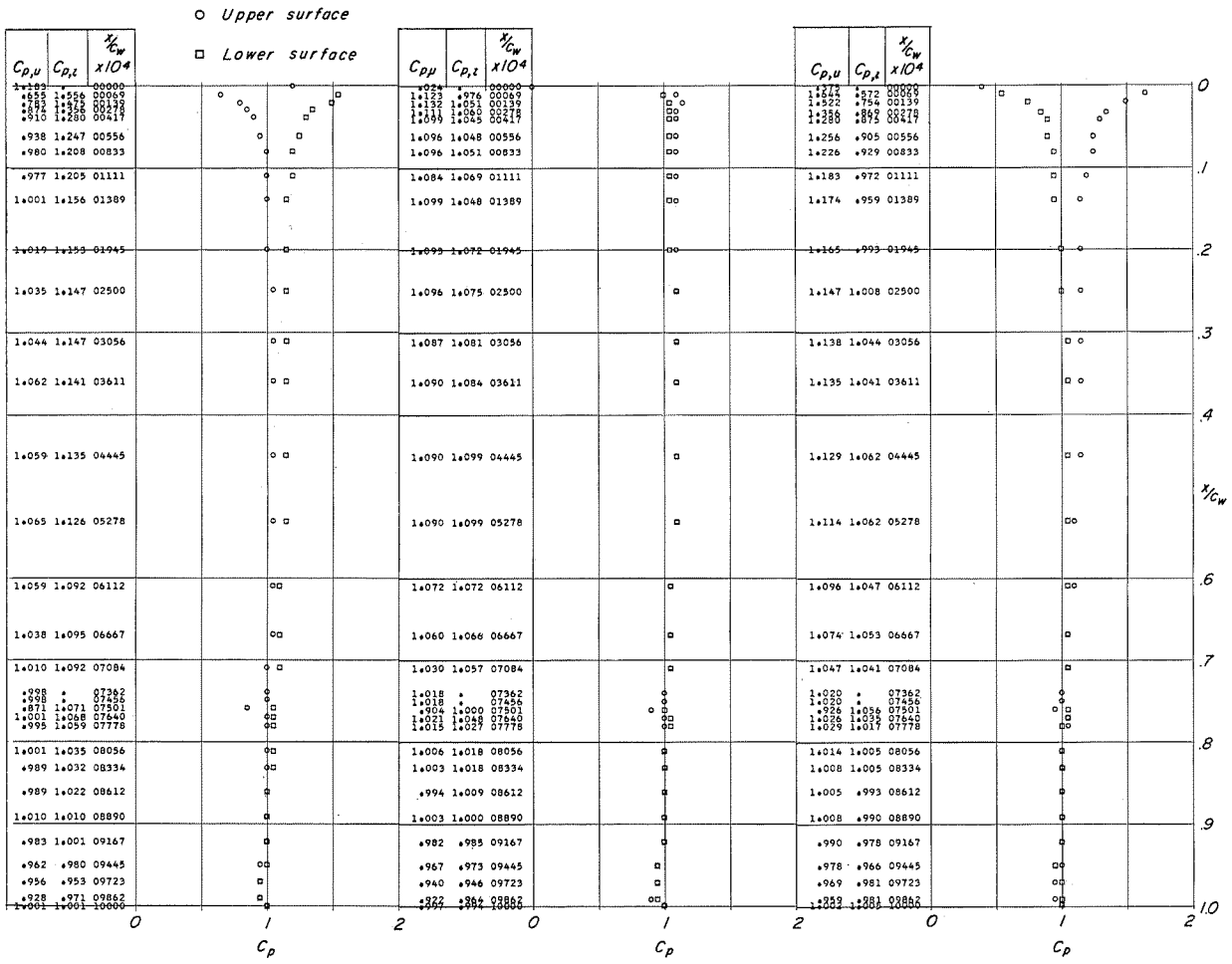
Figure 9.- Chordwise pressure distribution over model. $\delta_N = 0^\circ$; $\delta_f = 0^\circ$; plain wing; tabulated data of points plotted to left of plot.



(d) $\alpha = -6^\circ$.

(e) $\alpha = -4^\circ$.

Figure 9.- Continued.

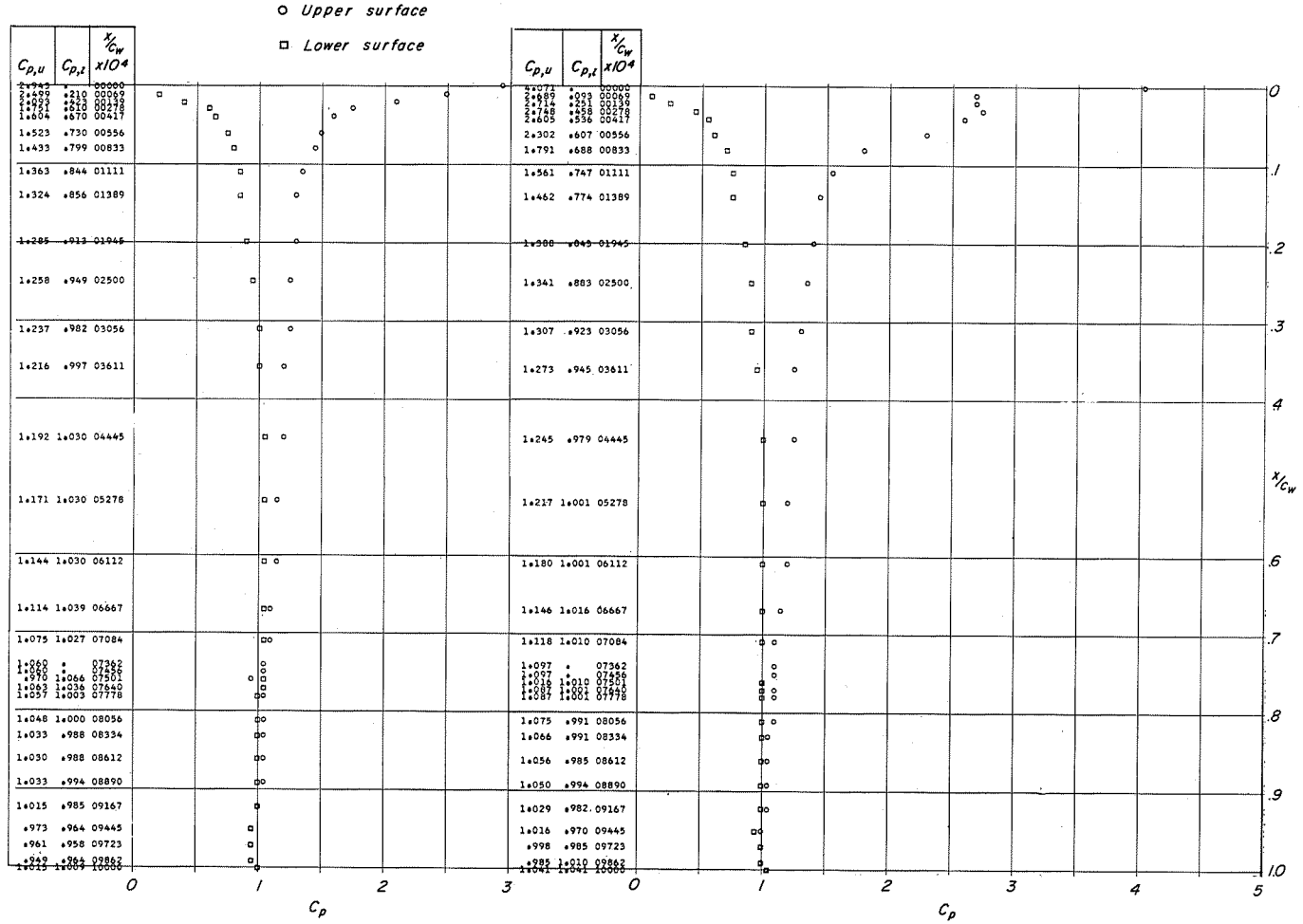


(f) $\alpha = -2^\circ$.

(g) $\alpha = 0^\circ$.

(h) $\alpha = 2^\circ$.

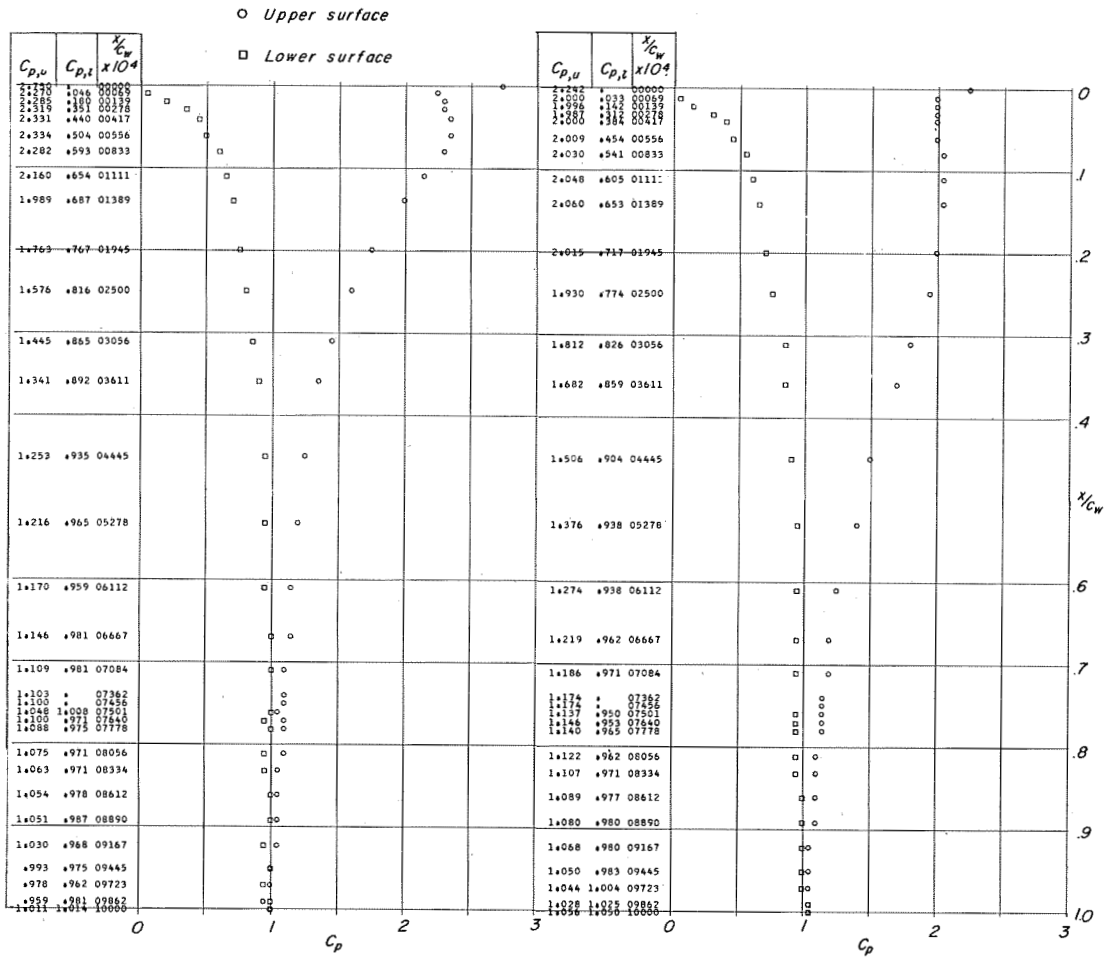
Figure 9.- Continued.



(i) $\alpha = 4^\circ$.

(j) $\alpha = 6^\circ$.

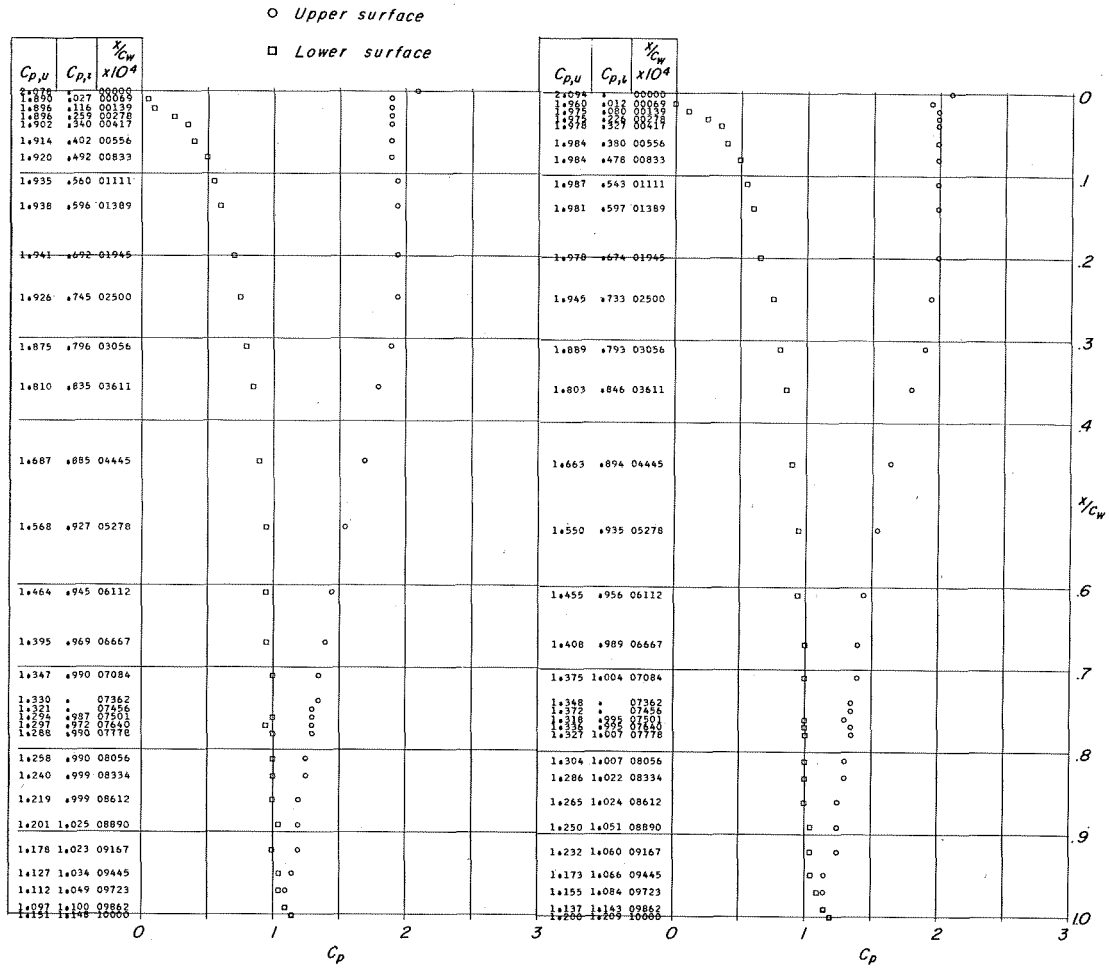
Figure 9.- Continued.



(k) $\alpha = 8^\circ$.

(l) $\alpha = 10^\circ$.

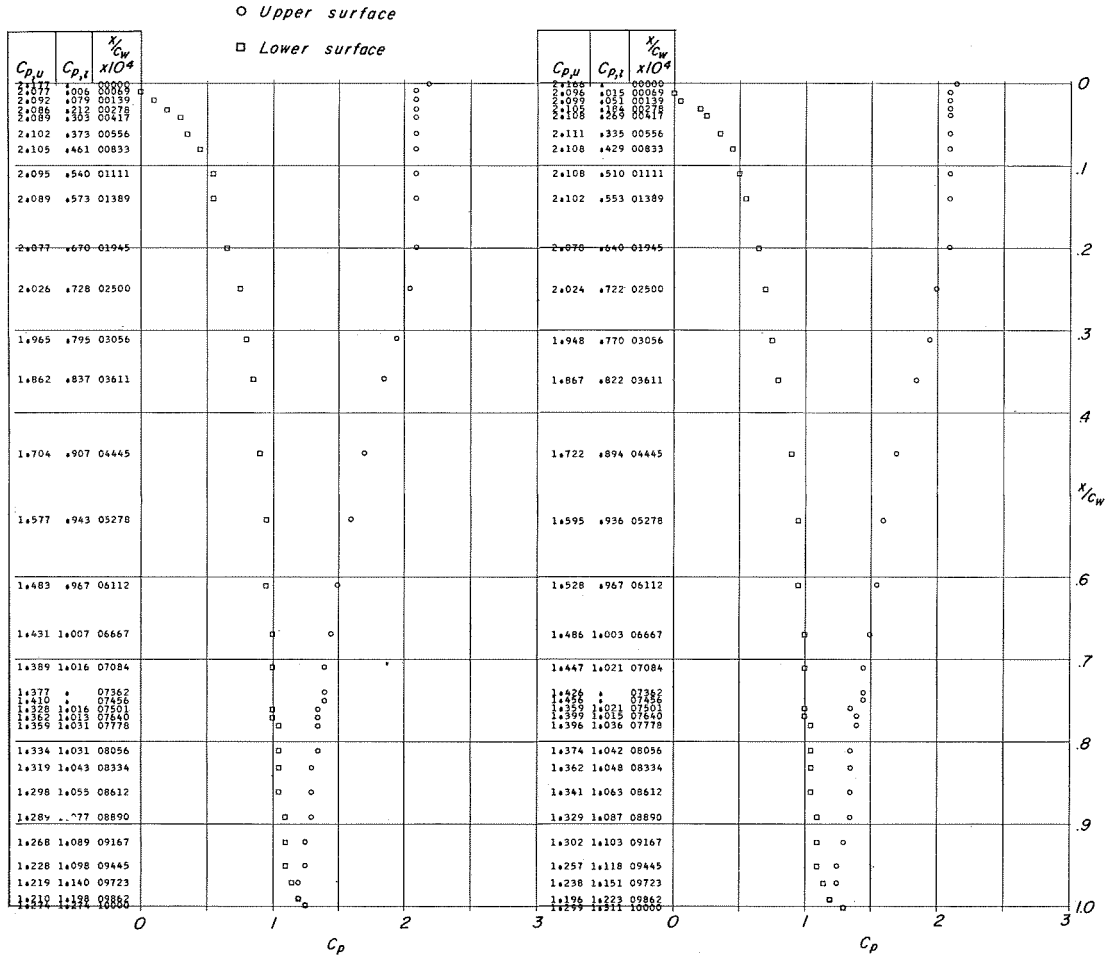
Figure 9.- Continued.



(m) $\alpha = 12^\circ$.

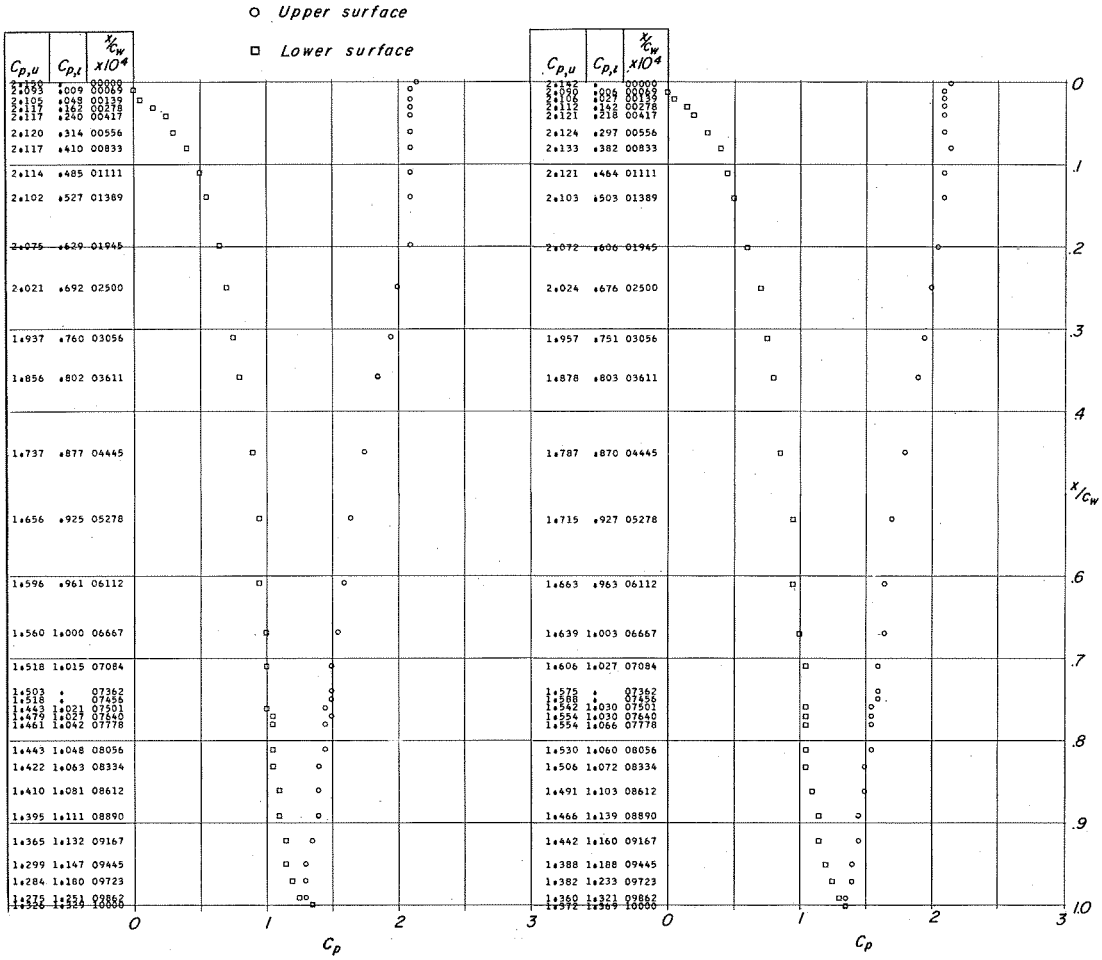
(n) $\alpha = 13^\circ$.

Figure 9.- Continued.



(o) $\alpha = 14^\circ$. (p) $\alpha = 15^\circ$.

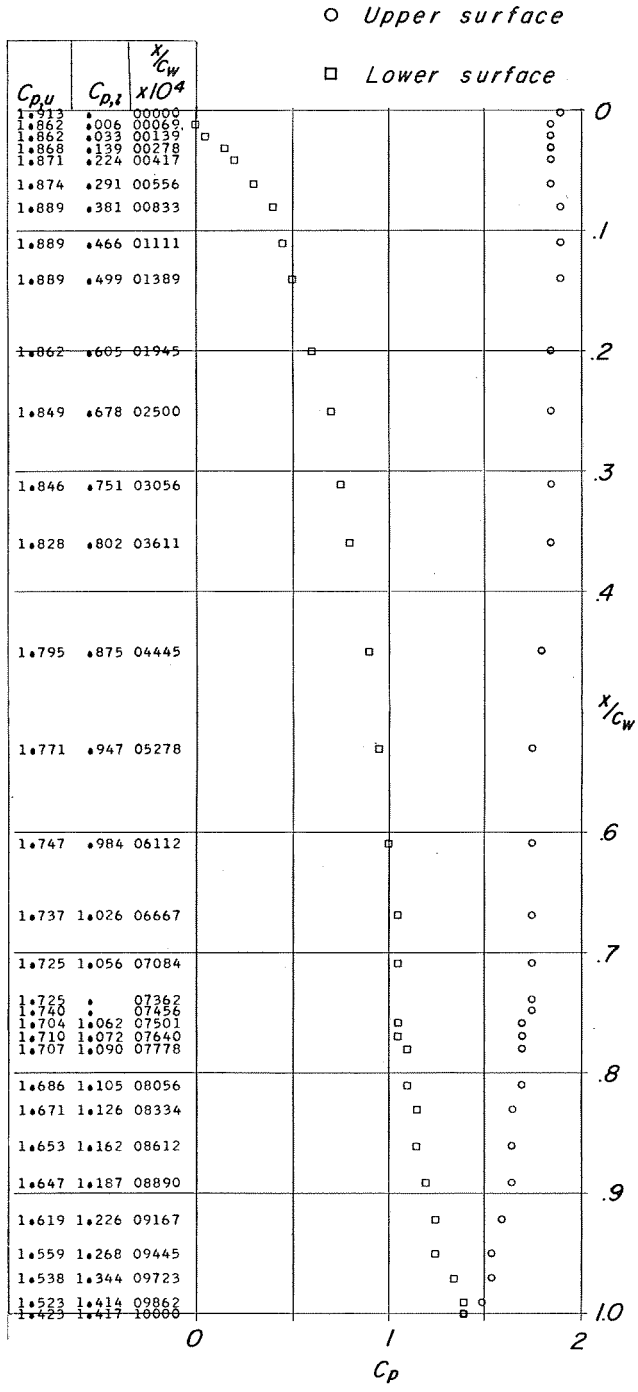
Figure 9.- Continued.



(q) $\alpha = 16^\circ$.

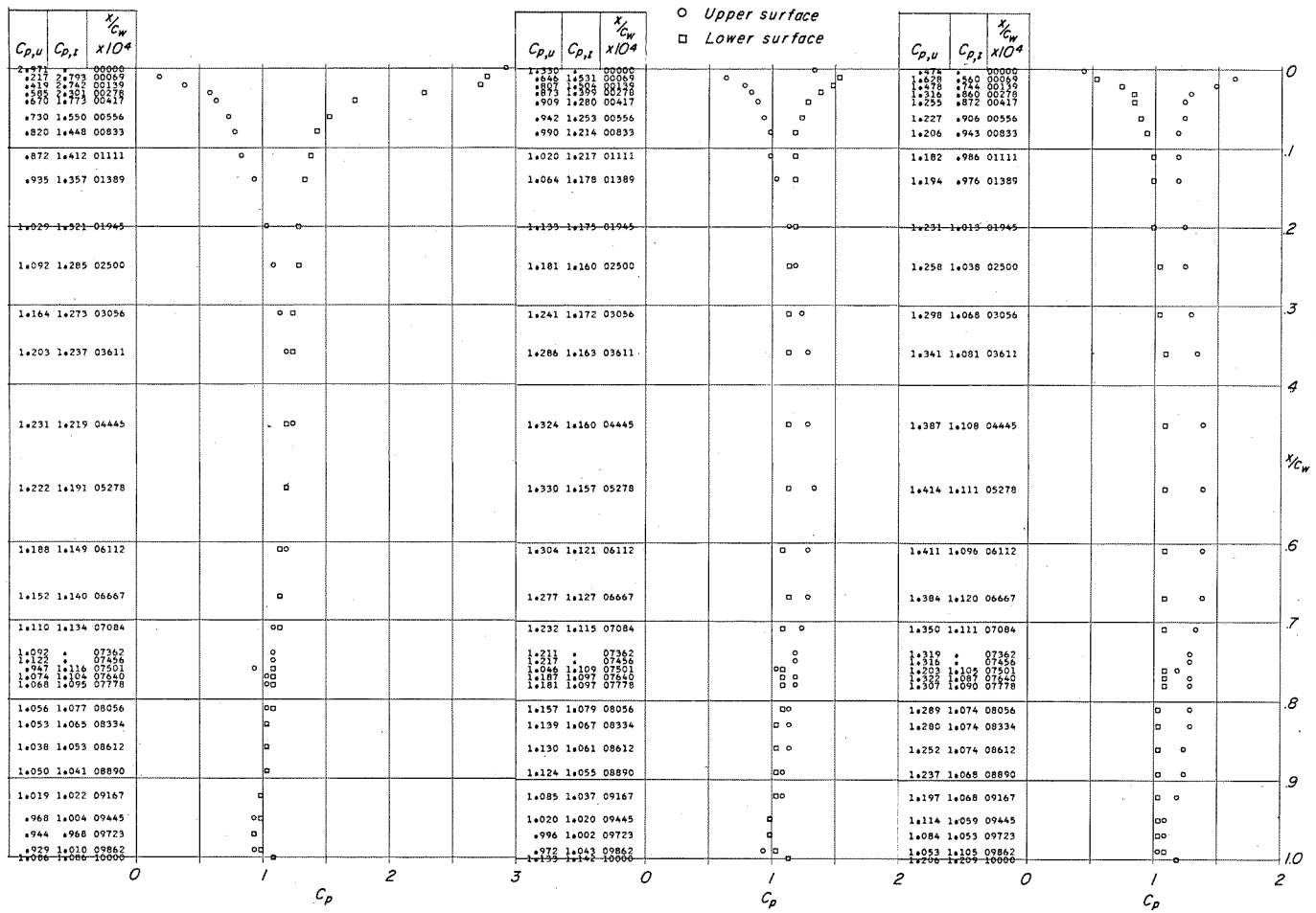
(r) $\alpha = 17^\circ$.

Figure 9.- Continued.



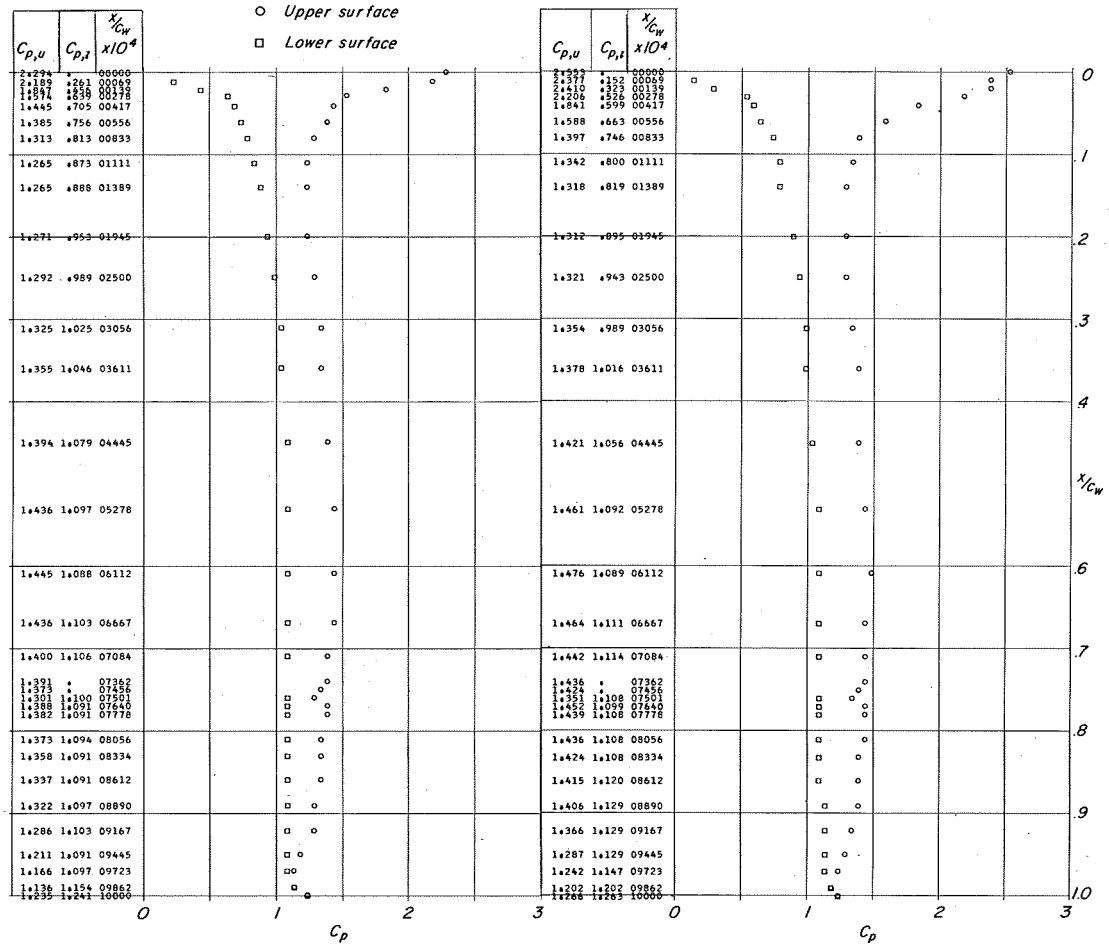
(s) $\alpha = 18^\circ$.

Figure 9.- Concluded.



(a) $\alpha = -4^\circ$. (b) $\alpha = 0^\circ$. (c) $\alpha = 4^\circ$.

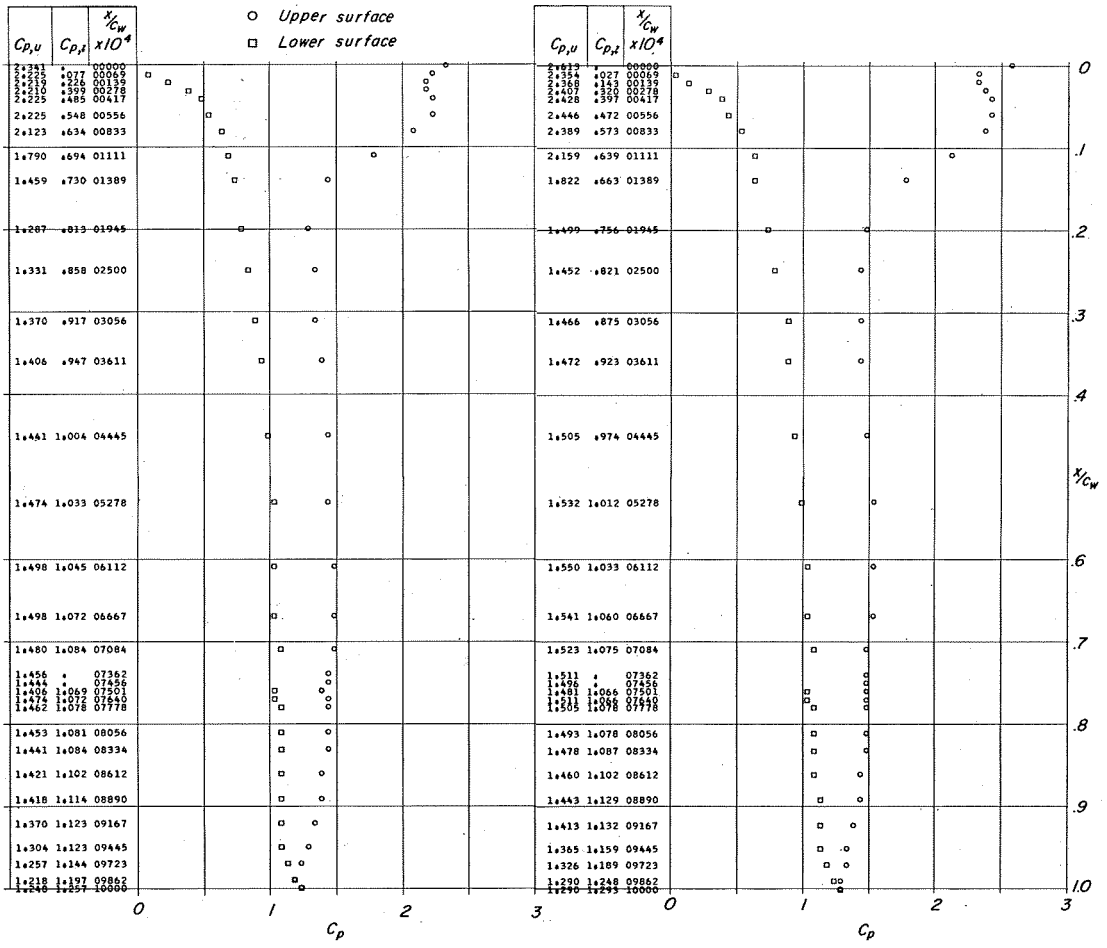
Figure 10.- Chordwise pressure distribution over model. $\delta_N = 0^\circ$; $\delta_f = 0^\circ$; half-span inboard spoiler hinged at 0.10c; tabulated data of points plotted to left of plot.



(d) $\alpha = 6^\circ$.

(e) $\alpha = 8^\circ$.

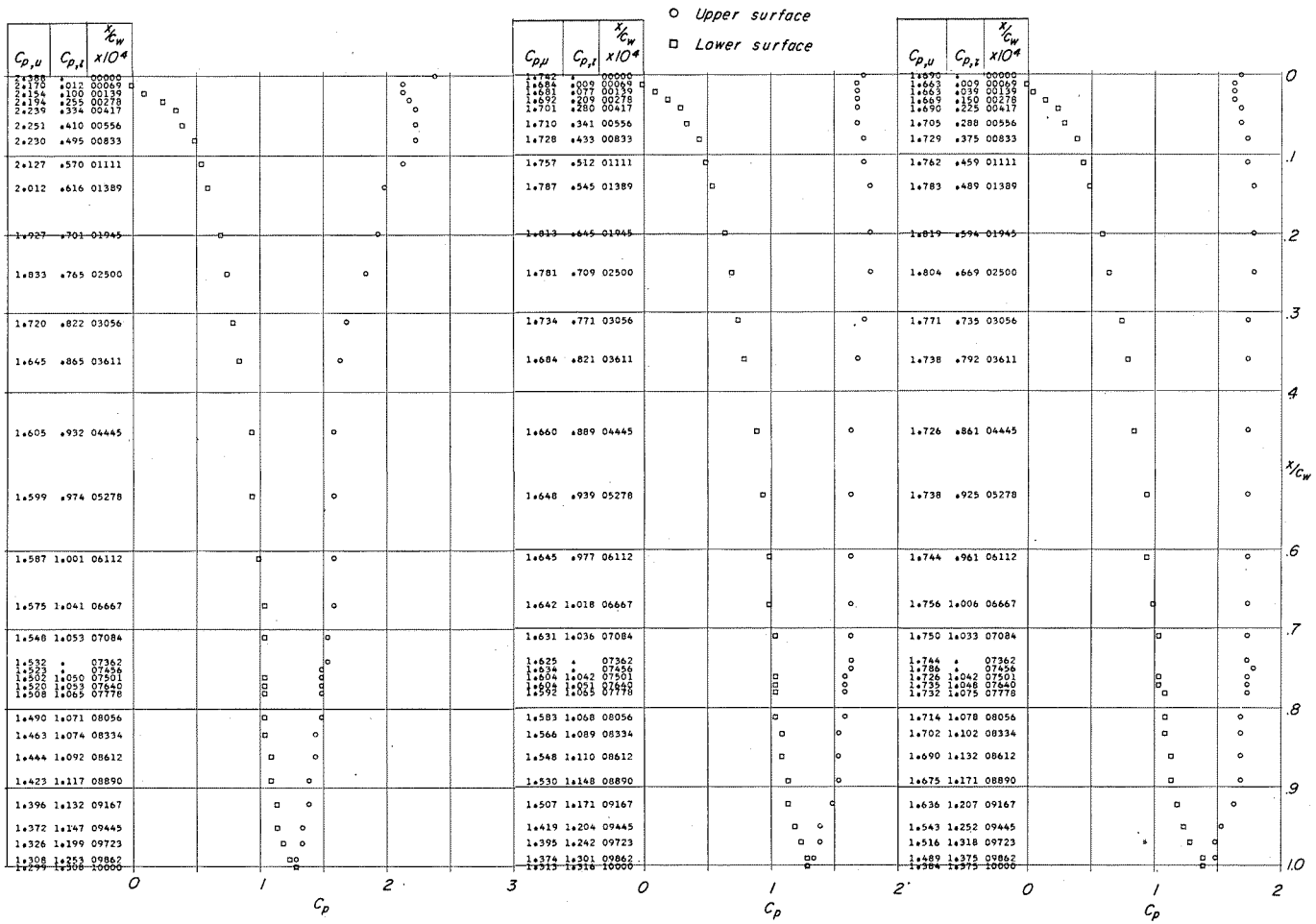
Figure 10.- Continued.



(f) $\alpha = 10^\circ$.

(g) $\alpha = 12^\circ$.

Figure 10.- Continued.

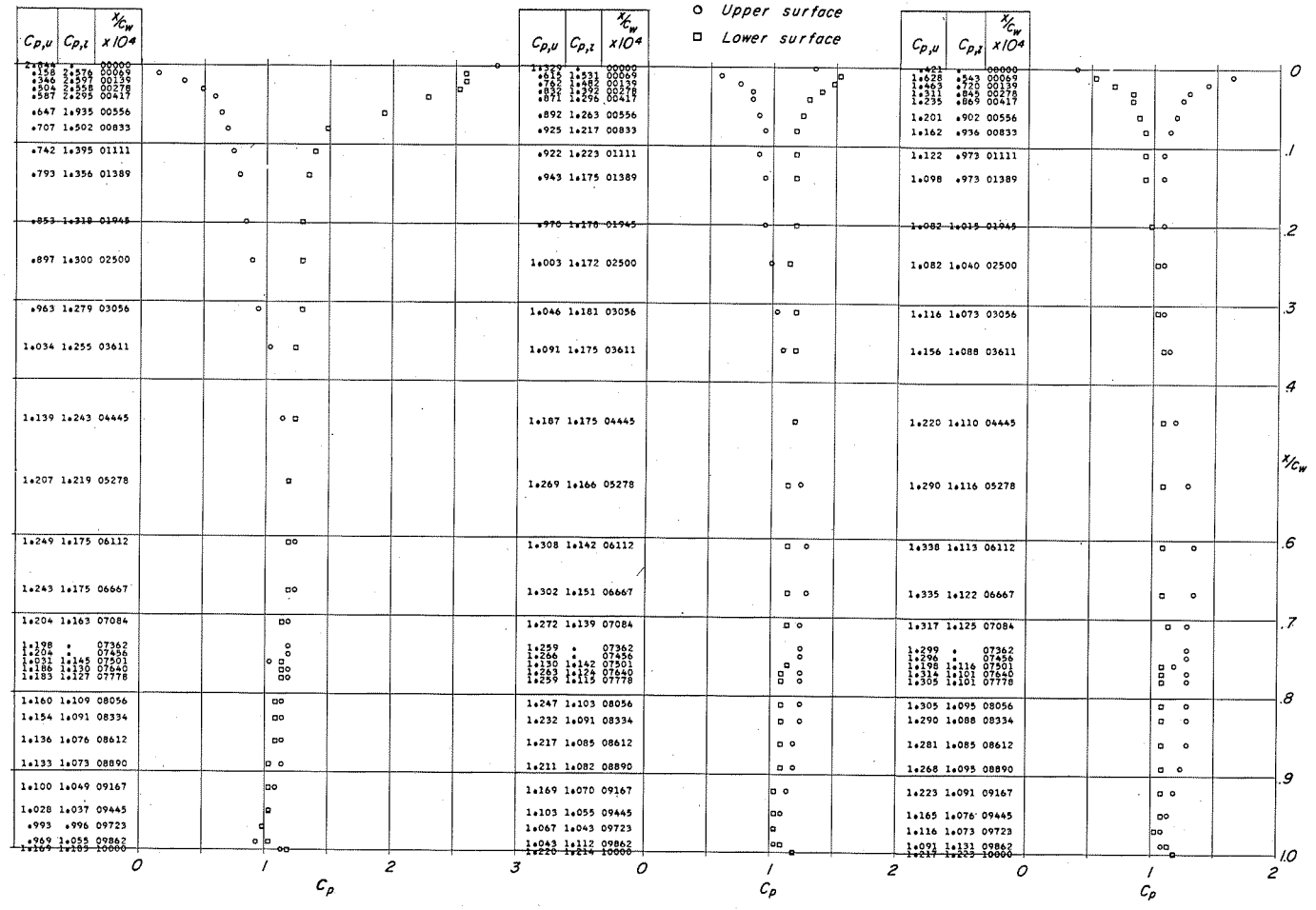


(h) $\alpha = 14^\circ$.

(i) $\alpha = 16^\circ$.

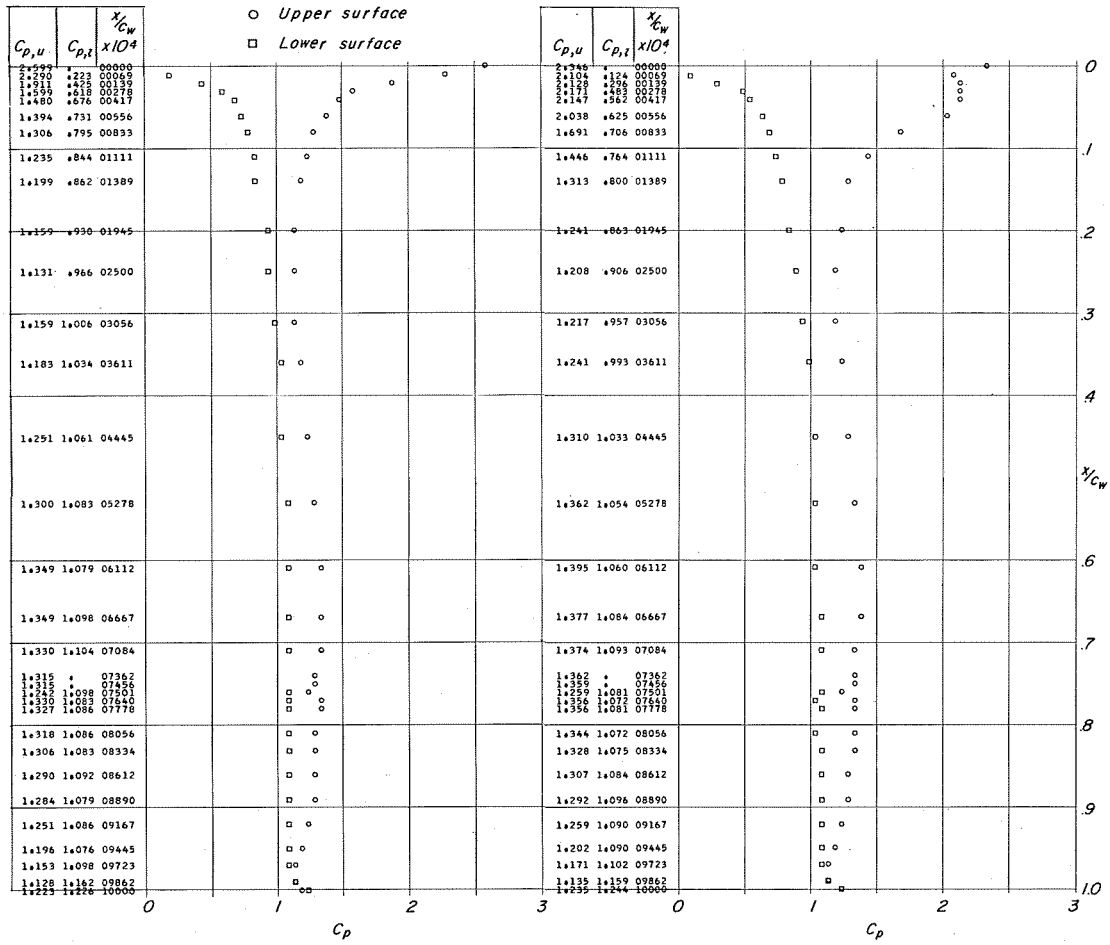
(j) $\alpha = 18^\circ$.

Figure 10.- Concluded.



(a) $\alpha = -4^\circ$. (b) $\alpha = 0^\circ$. (c) $\alpha = 4^\circ$.

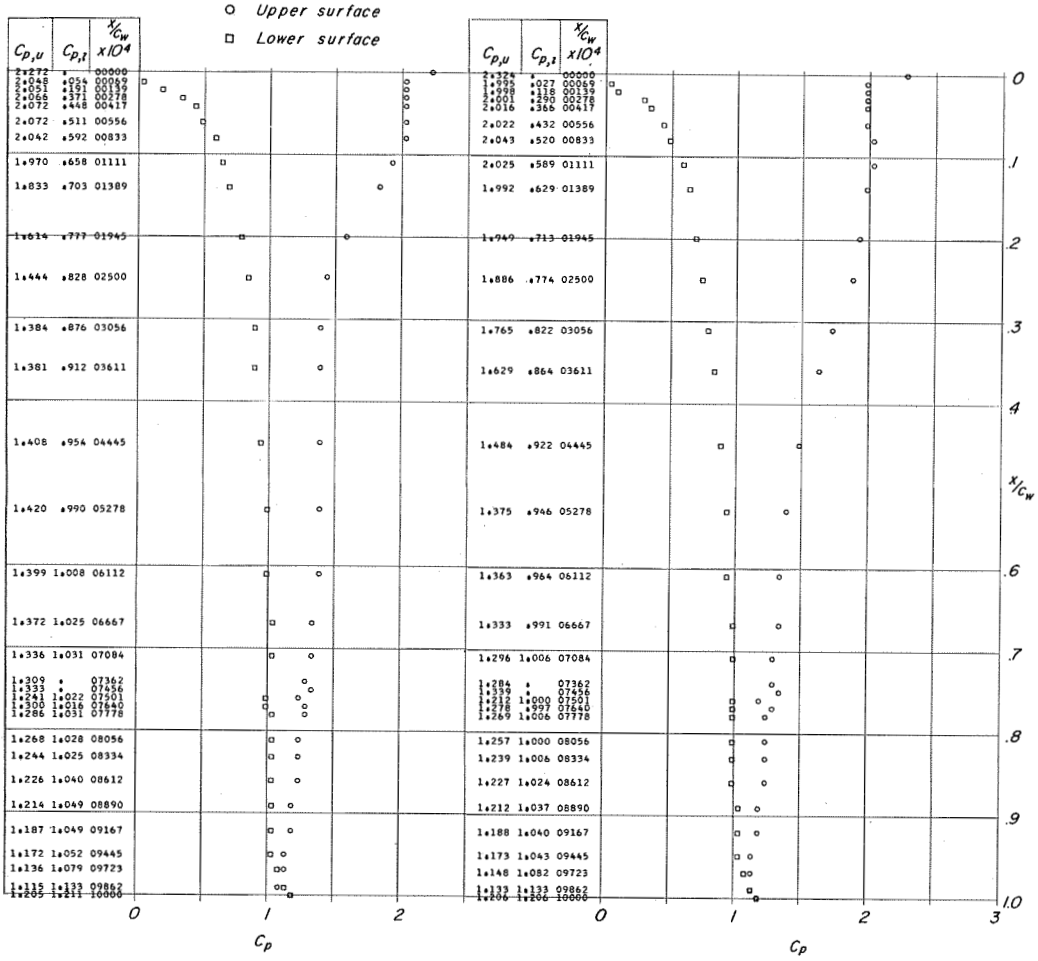
Figure 11.- Chordwise pressure distribution over model. $\delta_N = 0^\circ$; $\delta_f = 0^\circ$; half-span inboard spoiler hinged at 0.30c; tabulated data of points plotted to left of plot.



(d) $\alpha = 6^{\circ}$.

(e) $\alpha = 8^{\circ}$.

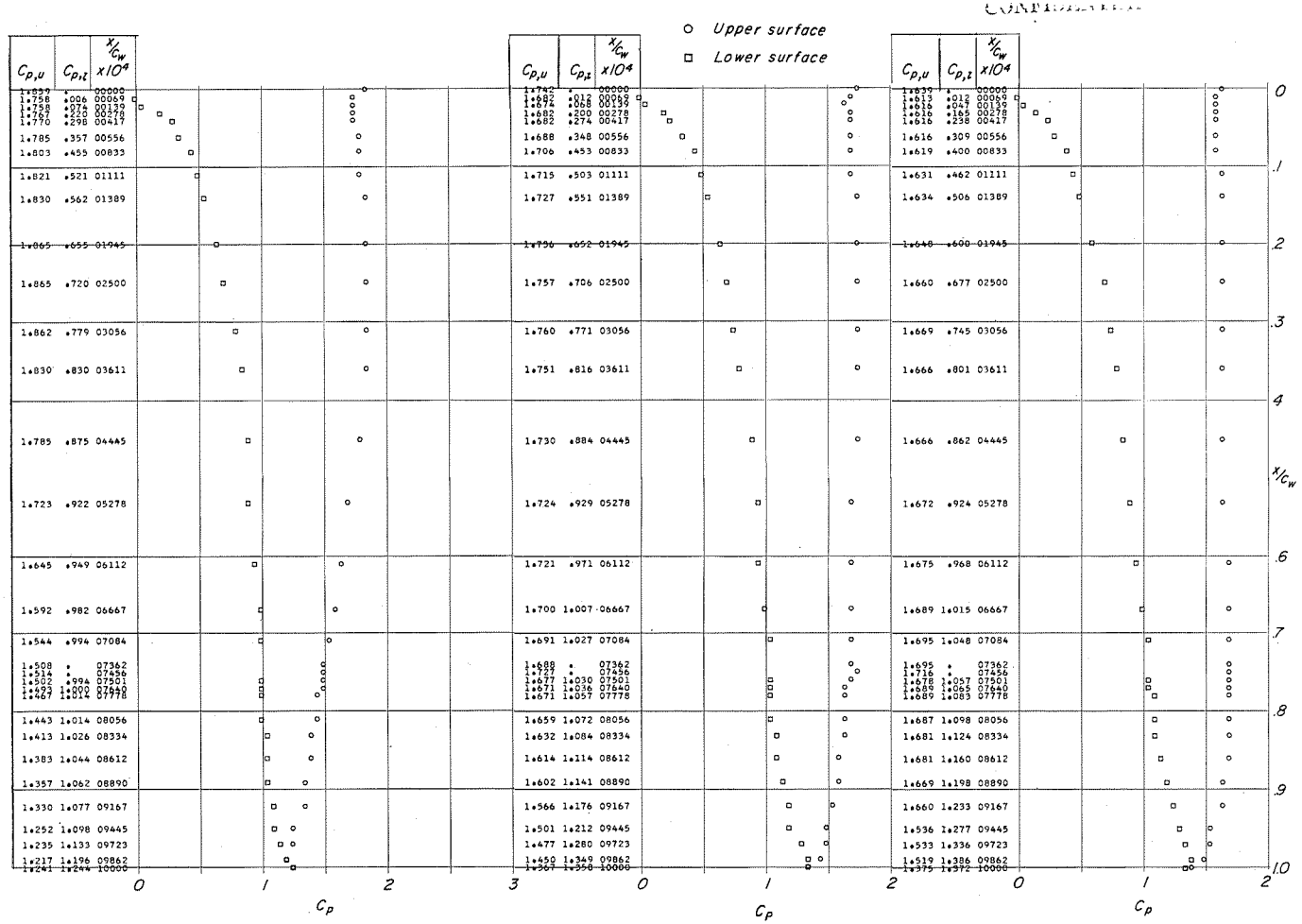
Figure 11.- Continued.



(f) $\alpha = 10^\circ$.

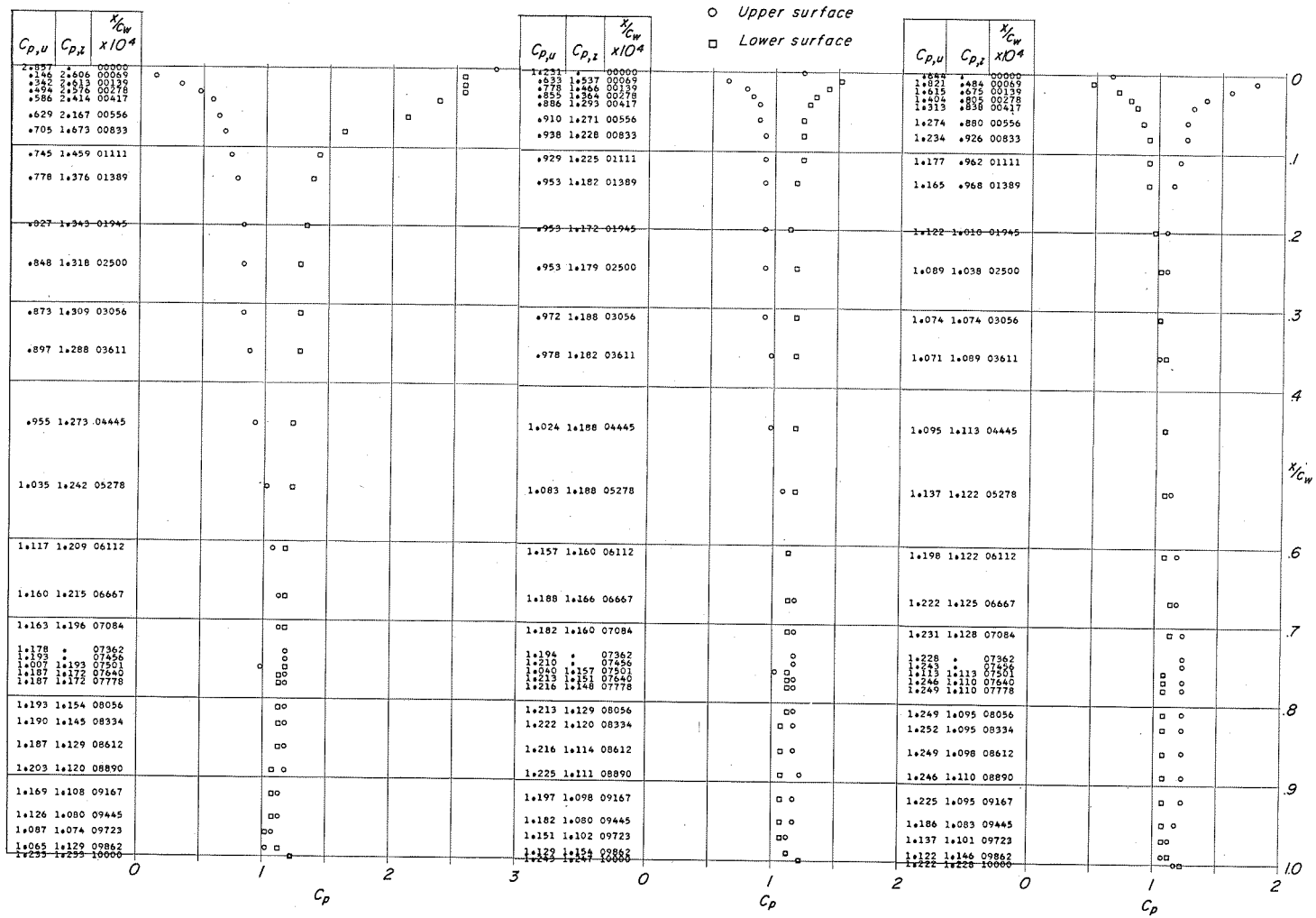
(g) $\alpha = 12^\circ$.

Figure 11.- Continued.



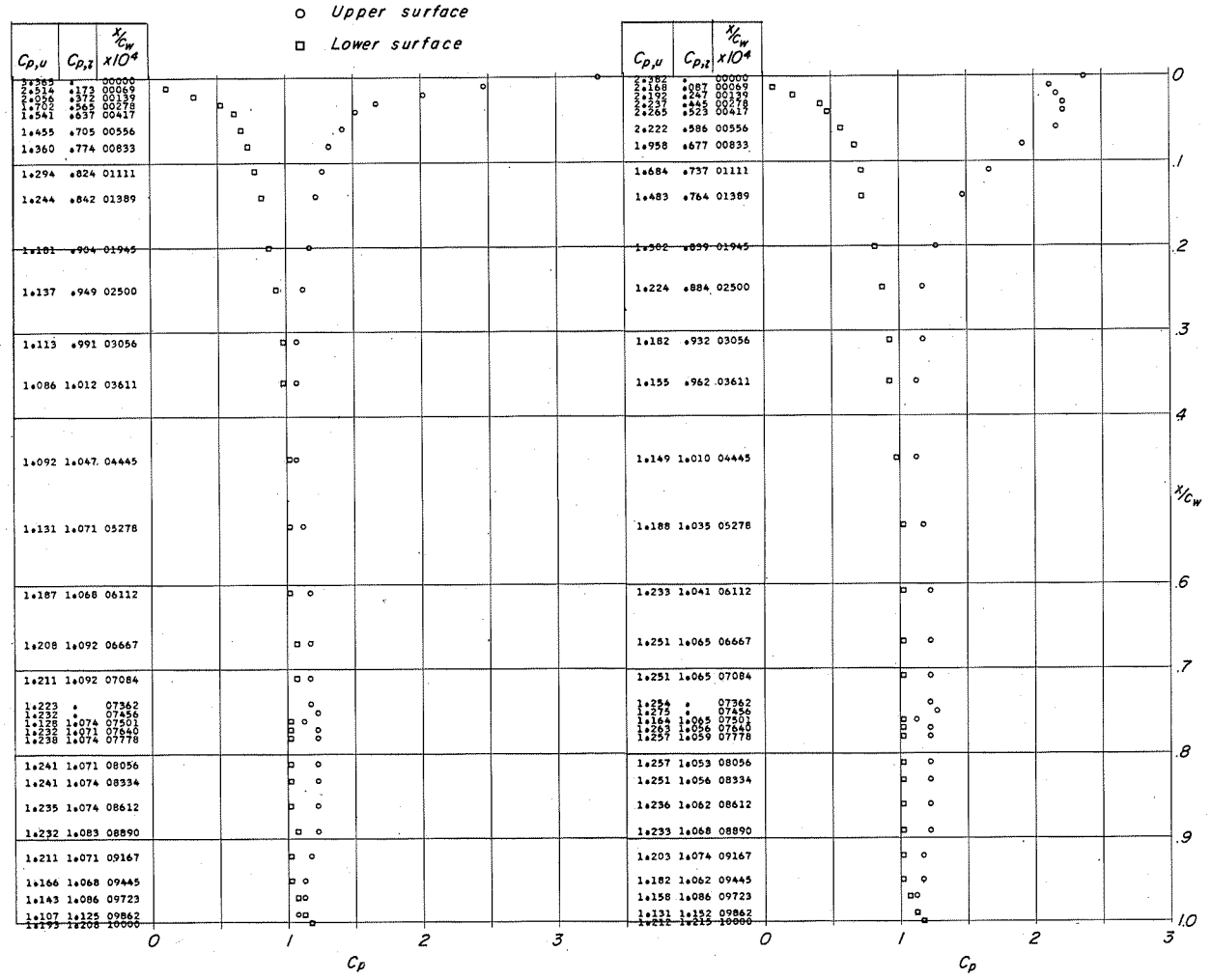
(h) $\alpha = 14^\circ$. (i) $\alpha = 16^\circ$. (j) $\alpha = 18^\circ$.

Figure 11.- Concluded.



(a) $\alpha = -4^\circ$. (b) $\alpha = 0^\circ$. (c) $\alpha = 4^\circ$.

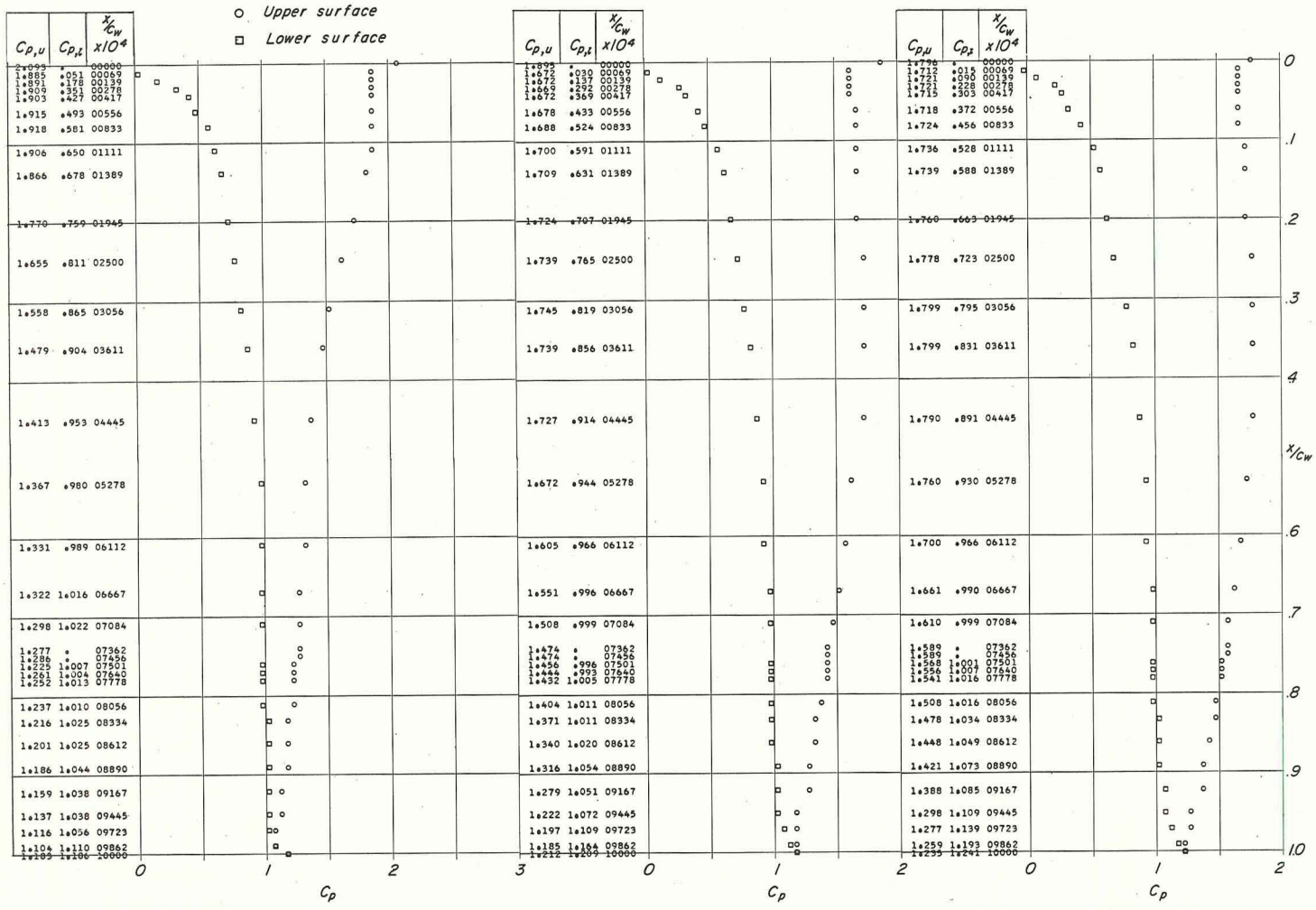
Figure 12.- Chordwise pressure distribution over model. $\delta_N = 0^\circ$; $\delta_f = 0^\circ$; half-span inboard spoiler hinged at 0.50c; tabulated data of points plotted to left of plot.



(d) $\alpha = 6^\circ$.

(e) $\alpha = 8^\circ$.

Figure 12.- Continued.

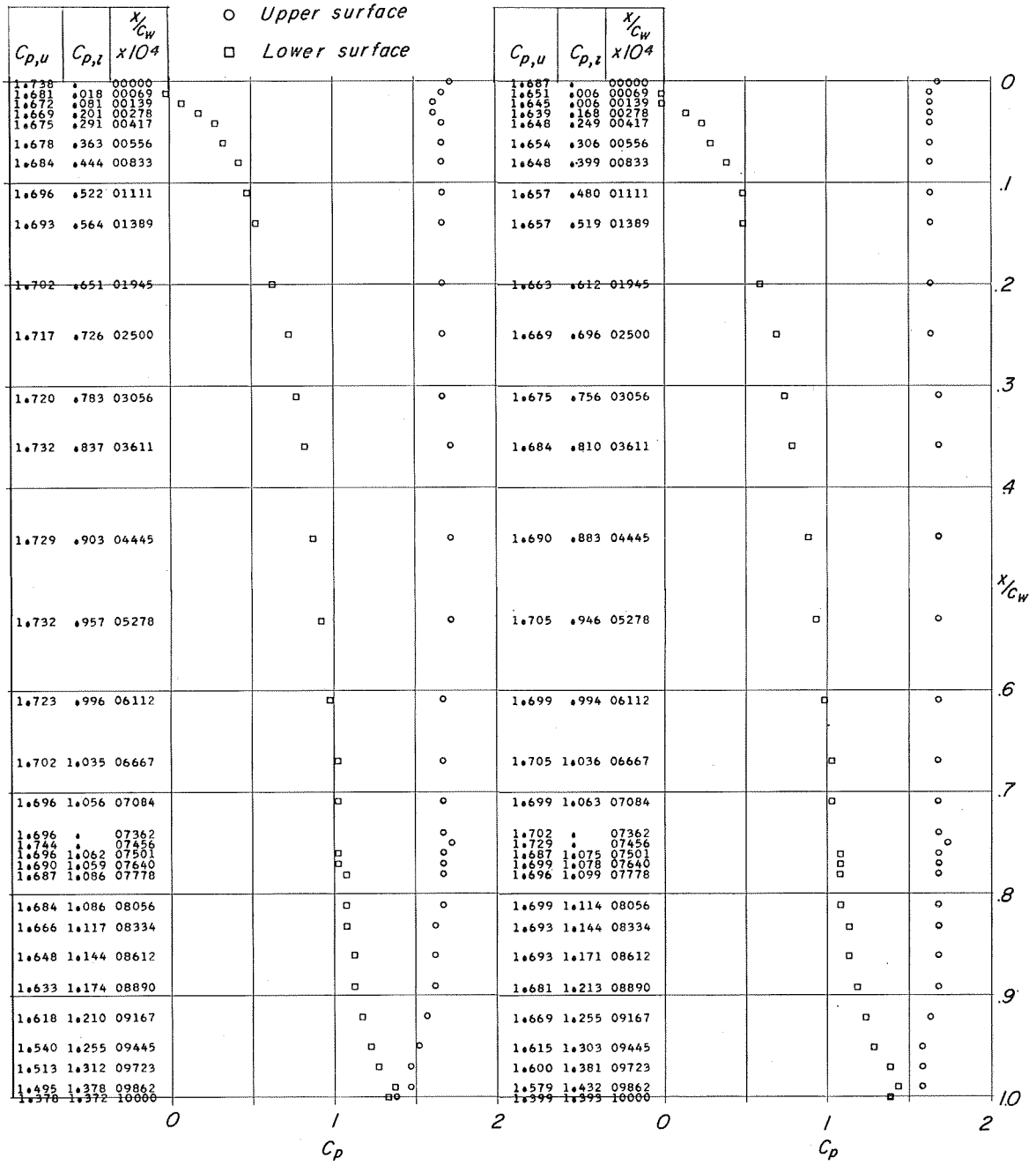


(f) $\alpha = 10^\circ$.

(g) $\alpha = 12^\circ$.

(h) $\alpha = 14^\circ$.

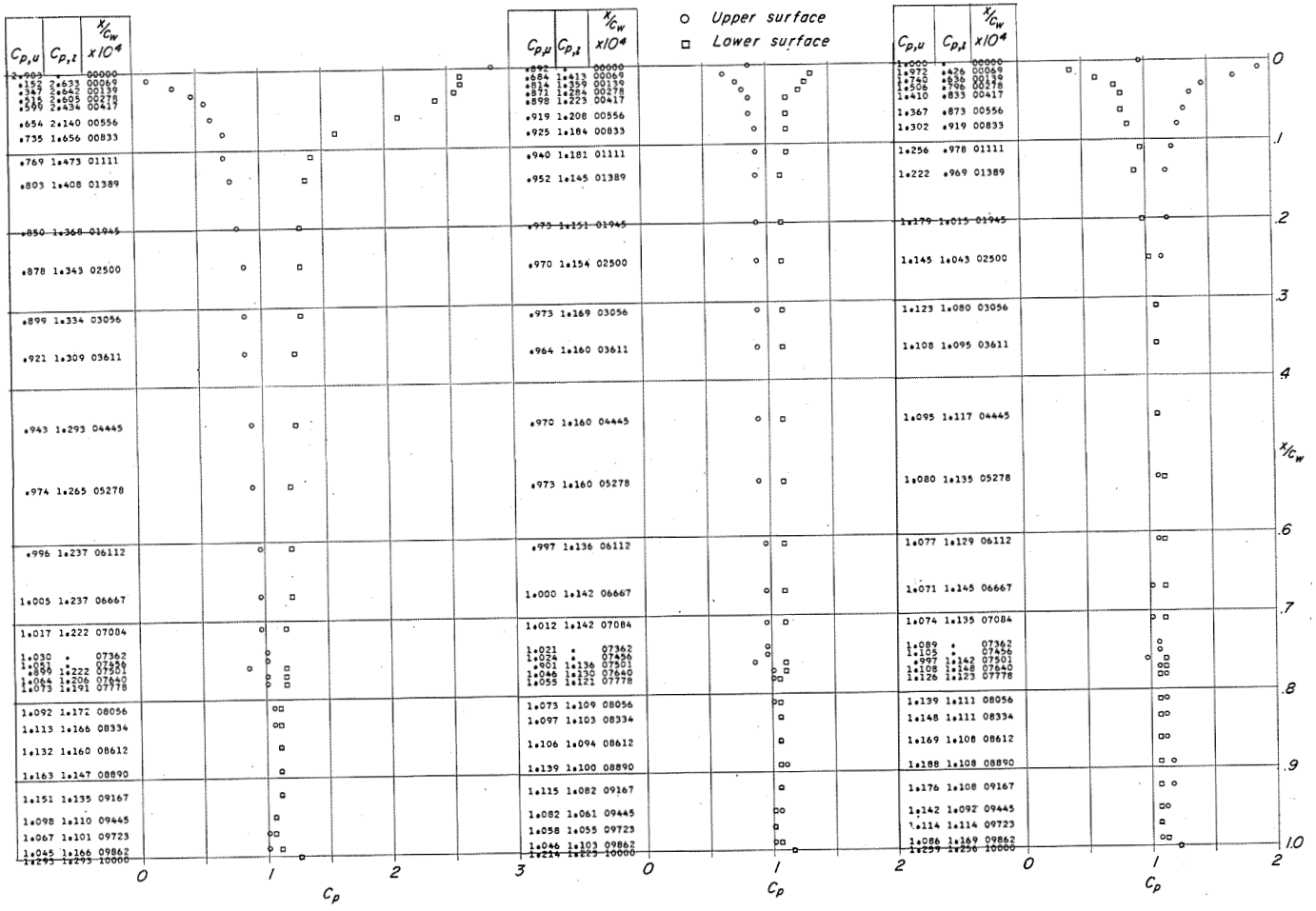
Figure 12.- Continued.



(i) $\alpha = 16^\circ$.

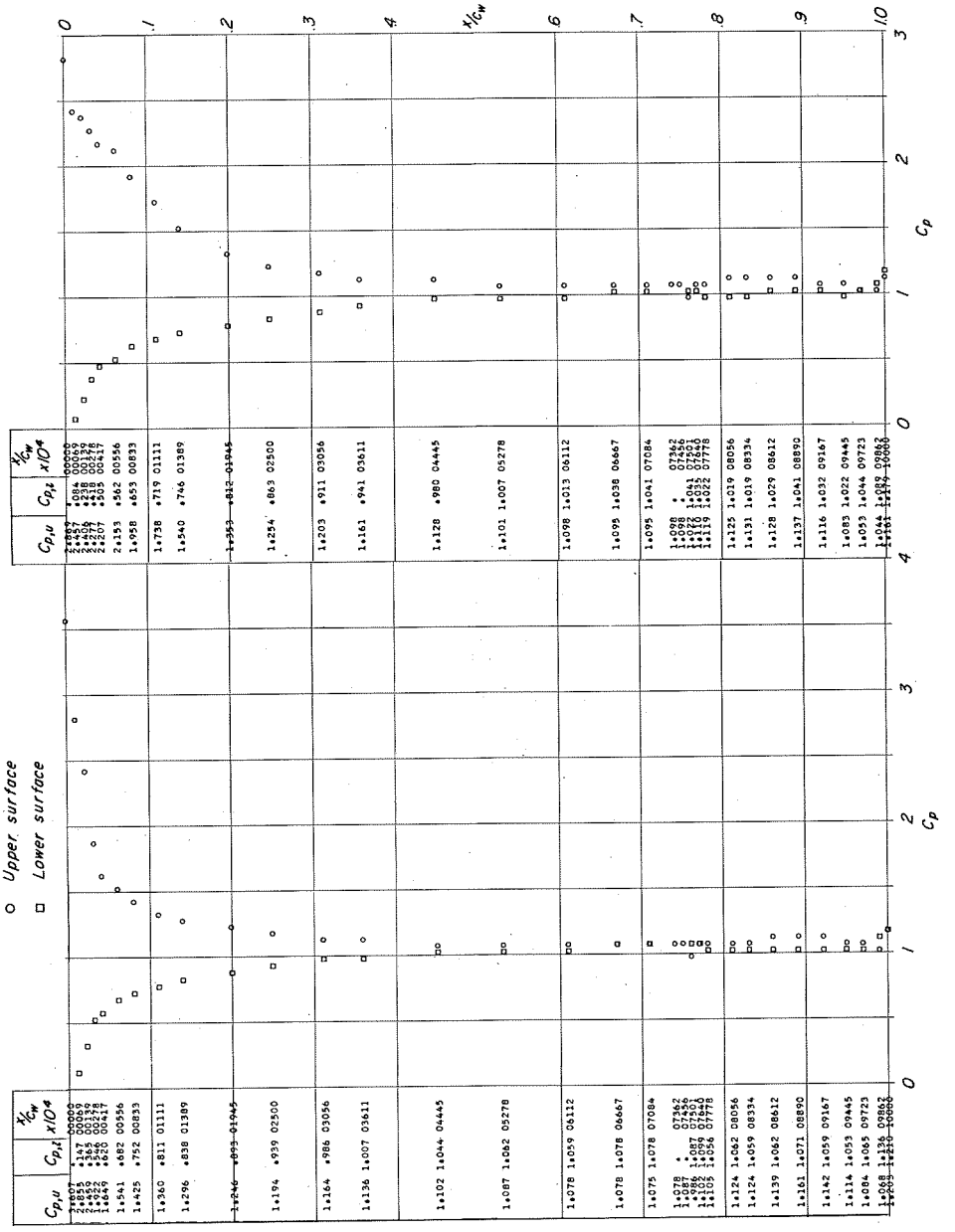
(j) $\alpha = 18^\circ$.

Figure 12.- Concluded.



(a) $\alpha = -4^\circ$. (b) $\alpha = 0^\circ$. (c) $\alpha = 4^\circ$.

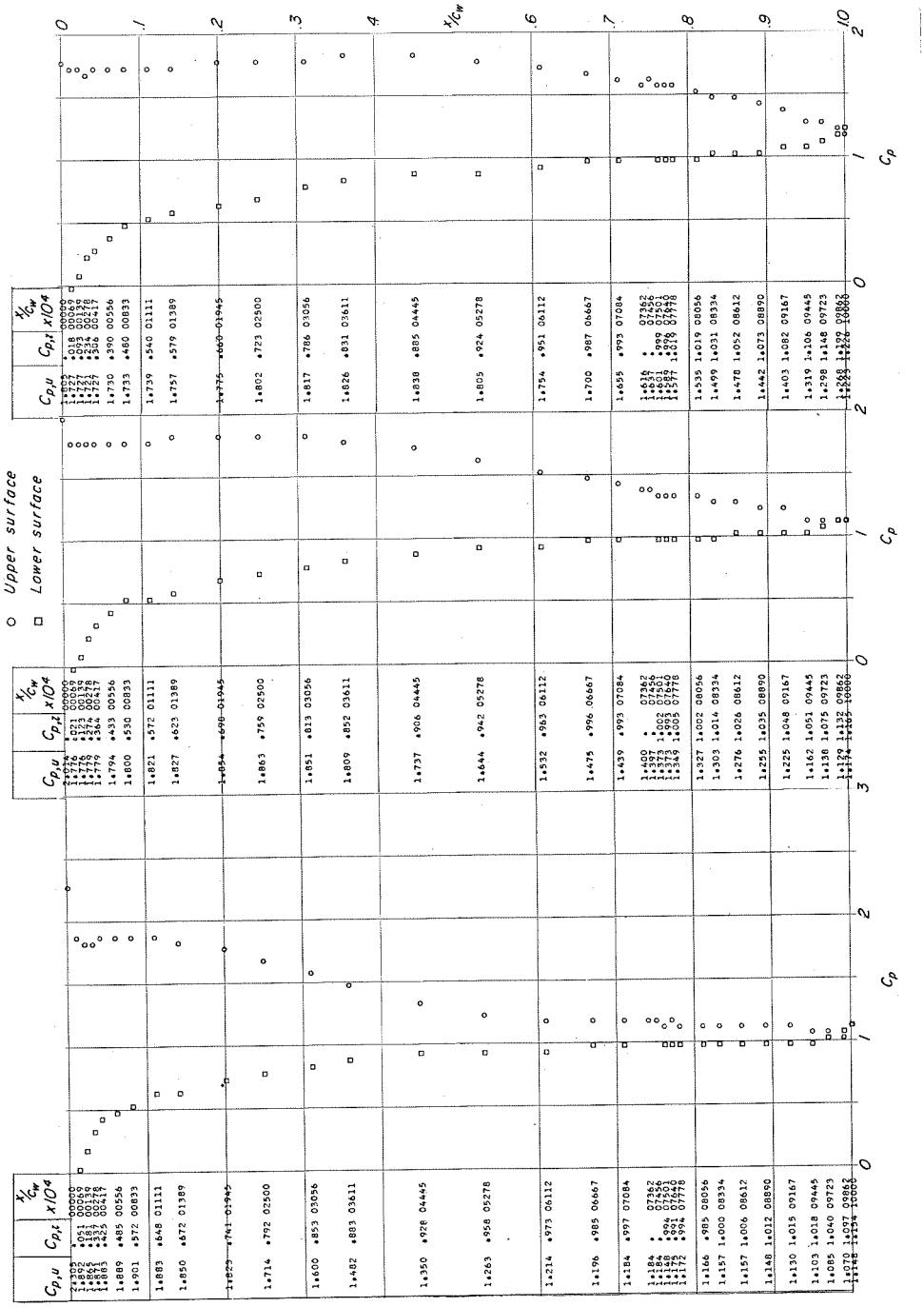
Figure 13.- Chordwise pressure distribution over model. $\delta_N = 0^\circ$; $\delta_f = 0^\circ$; half-span inboard spoiler hinged at 0.70c; tabulated data of points plotted to left of plot.



(d) $\alpha = 6°$.

(e) $\alpha = 8°$.

Figure 13.- Continued.

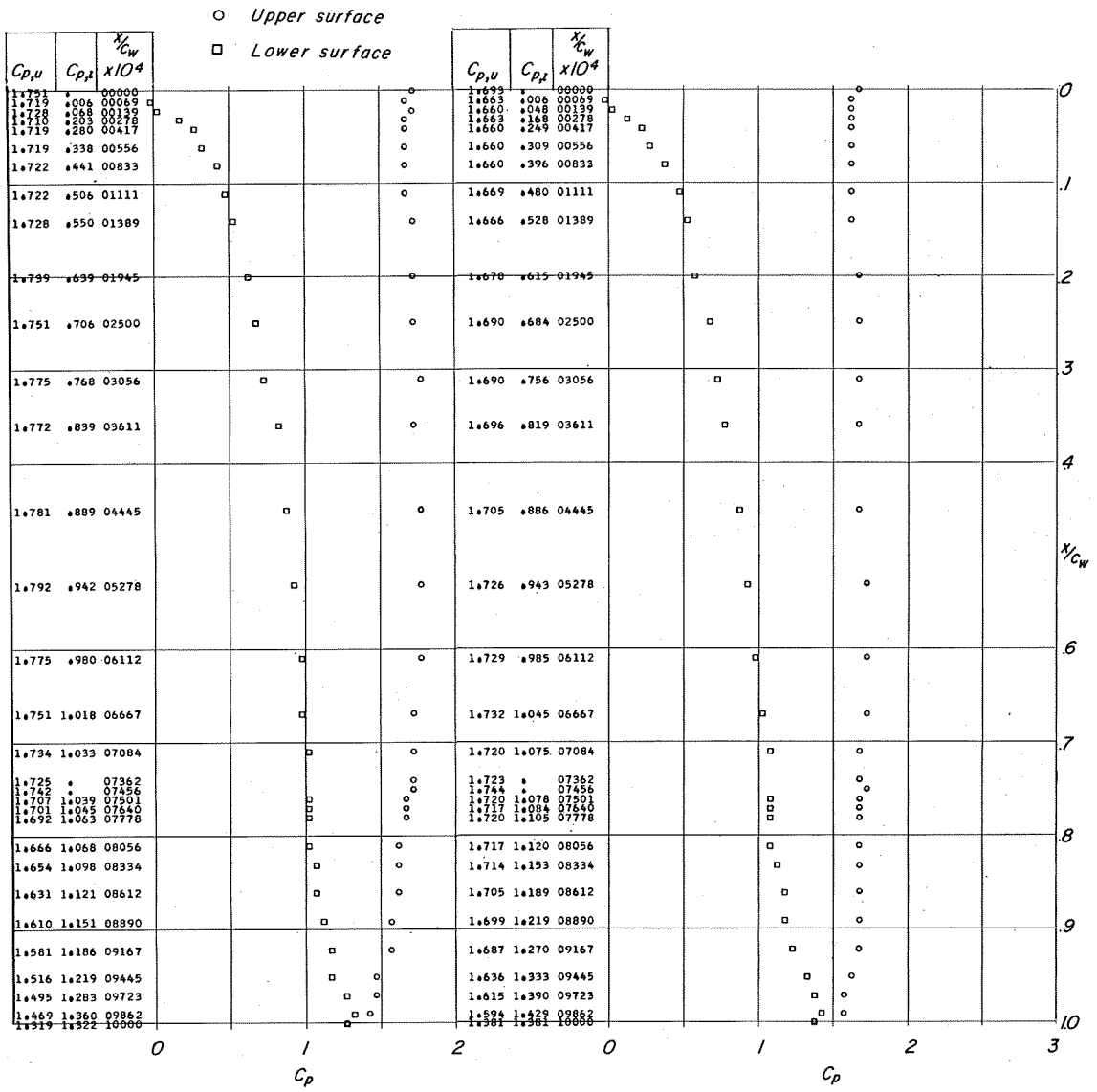


(f) $\alpha = 10^\circ$.

(g) $\alpha = 12^\circ$.

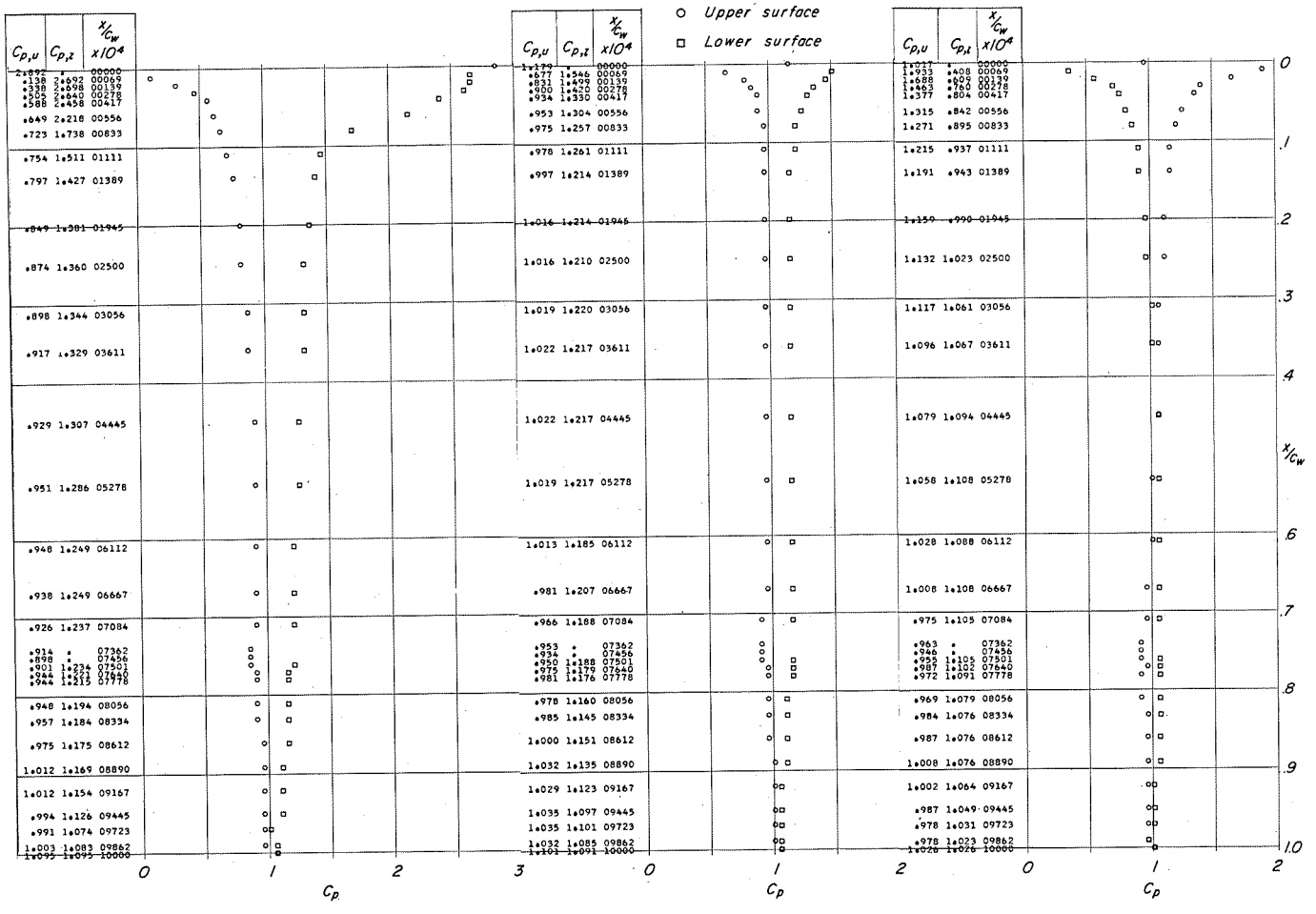
(h) $\alpha = 14^\circ$.

Figure 13.- Continued.



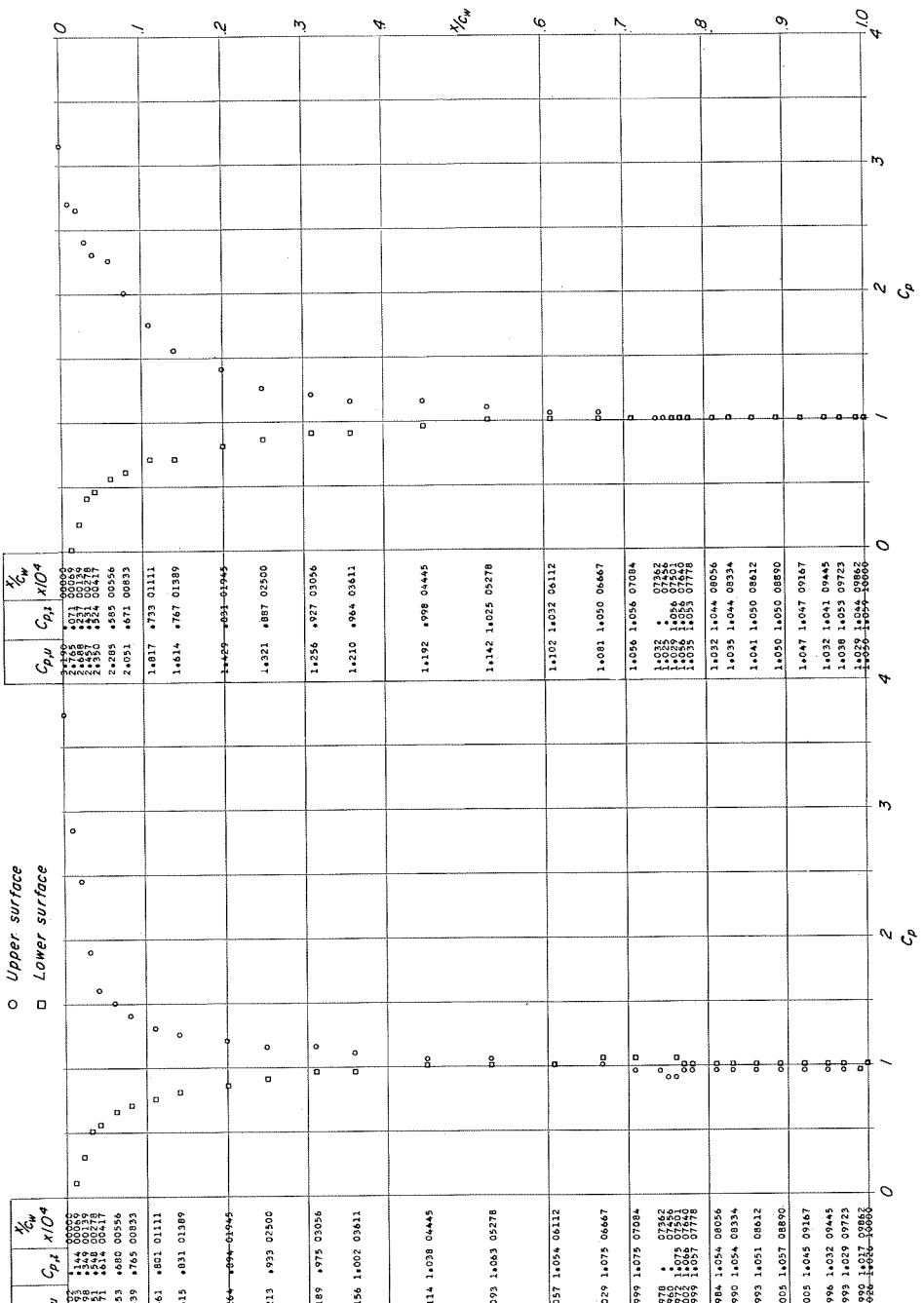
(i) $\alpha = 16^\circ$. (j) $\alpha = 18^\circ$.

Figure 13.- Concluded.



(a) $\alpha = -4^\circ$. (b) $\alpha = 0^\circ$. (c) $\alpha = 4^\circ$.

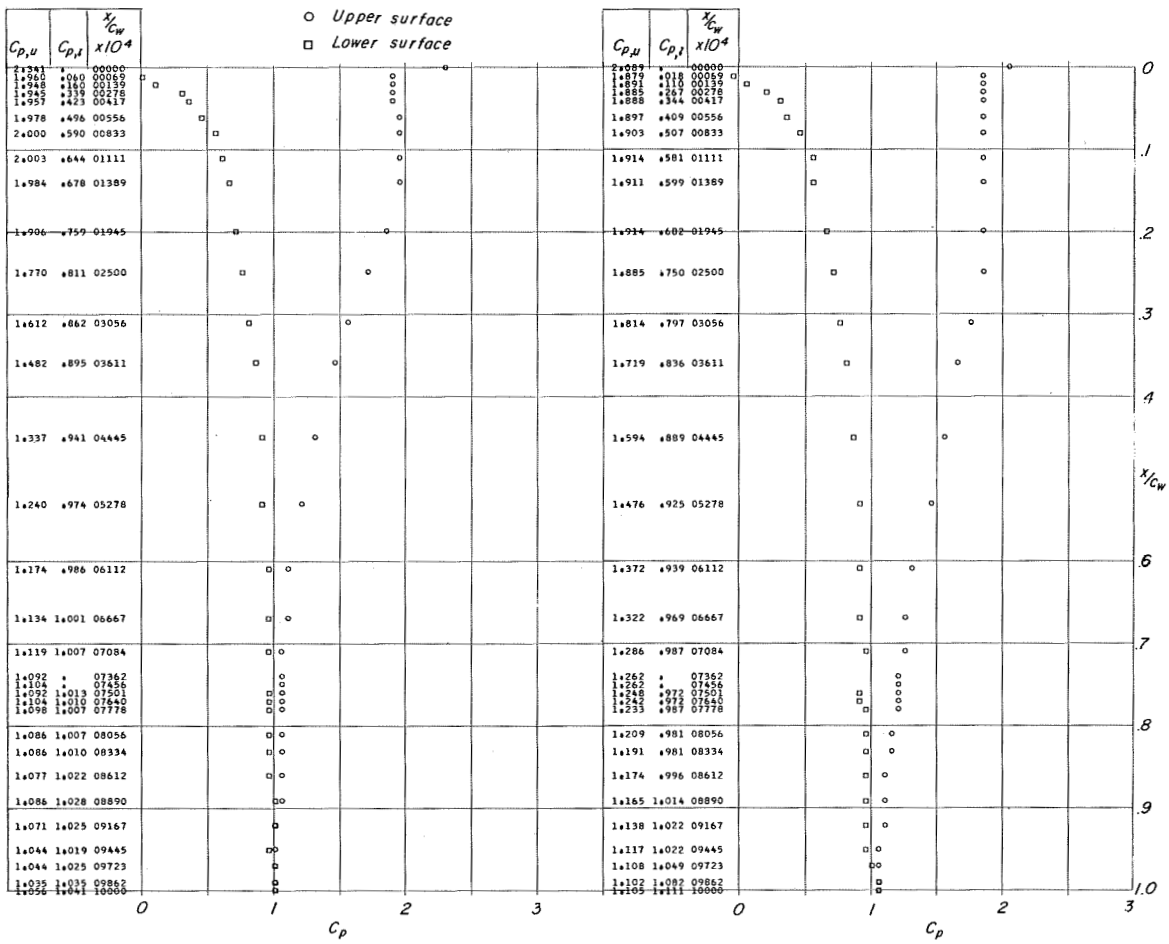
Figure 14.- Chordwise pressure distribution over model. $\delta_N = 0^\circ$; $\delta_f = 0^\circ$; half-span inboard spoiler hinged at 0.90c; tabulated data of points plotted to left of plot.



(d) $\alpha = 6°$.

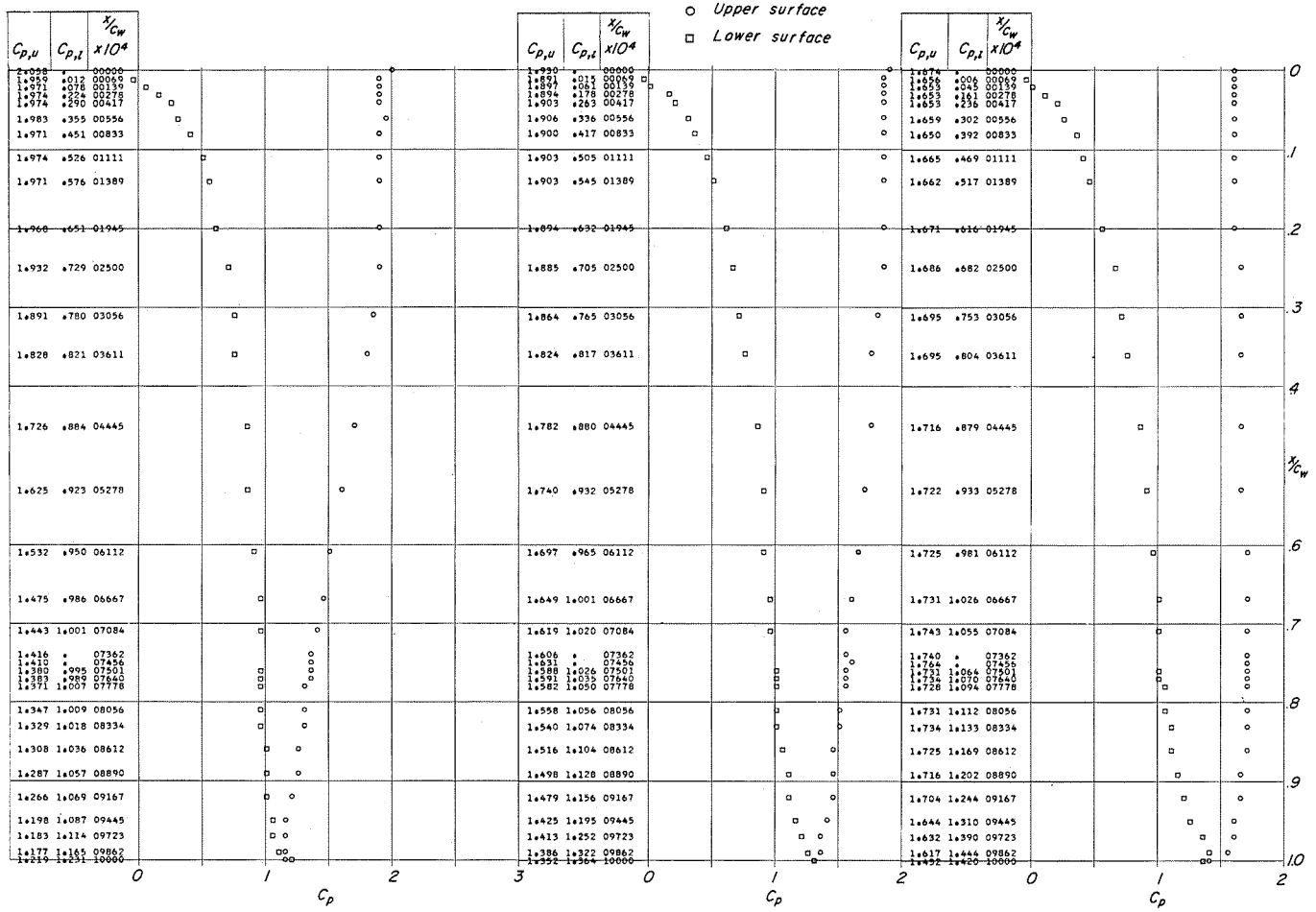
(e) $\alpha = 8°$.

Figure 14.- Continued.



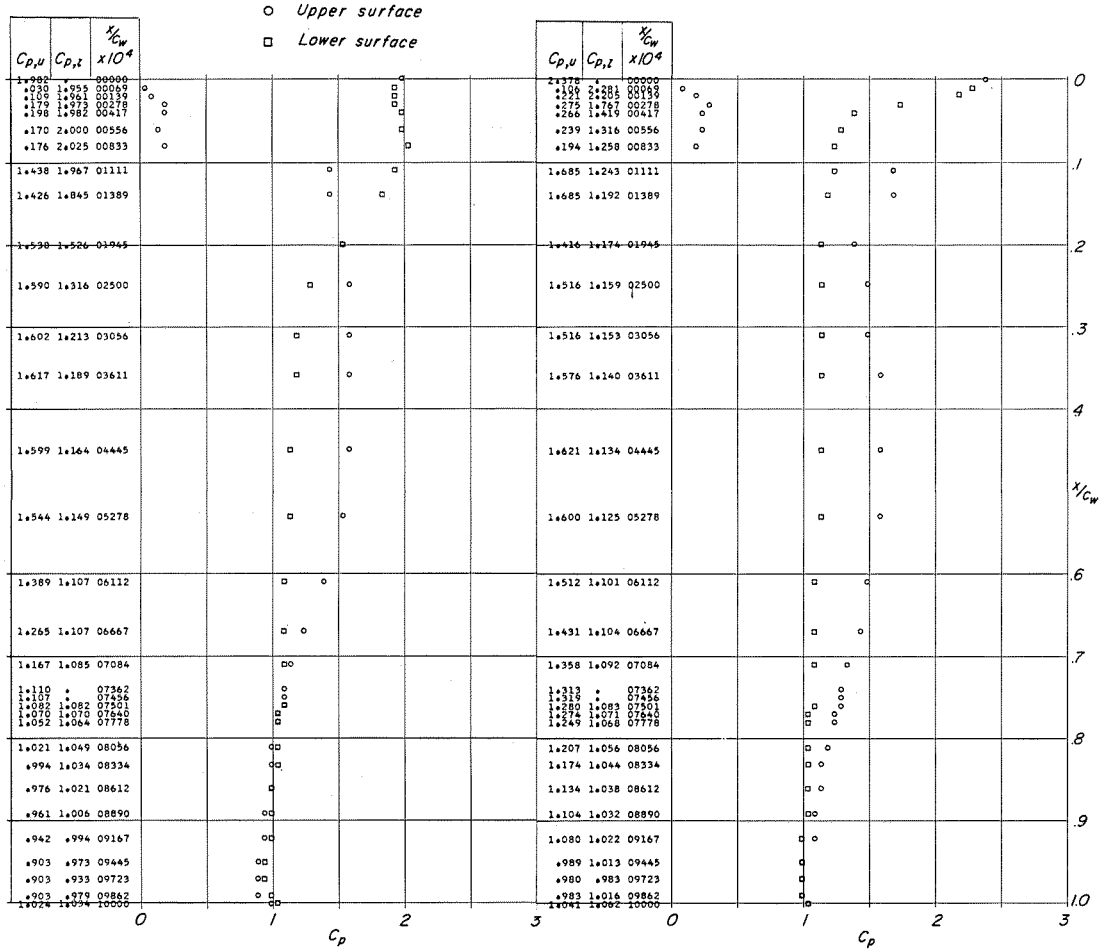
(f) $\alpha = 10^\circ$. (g) $\alpha = 12^\circ$.

Figure 14.- Continued.



(h) $\alpha = 14^\circ$. (i) $\alpha = 16^\circ$. (j) $\alpha = 18^\circ$.

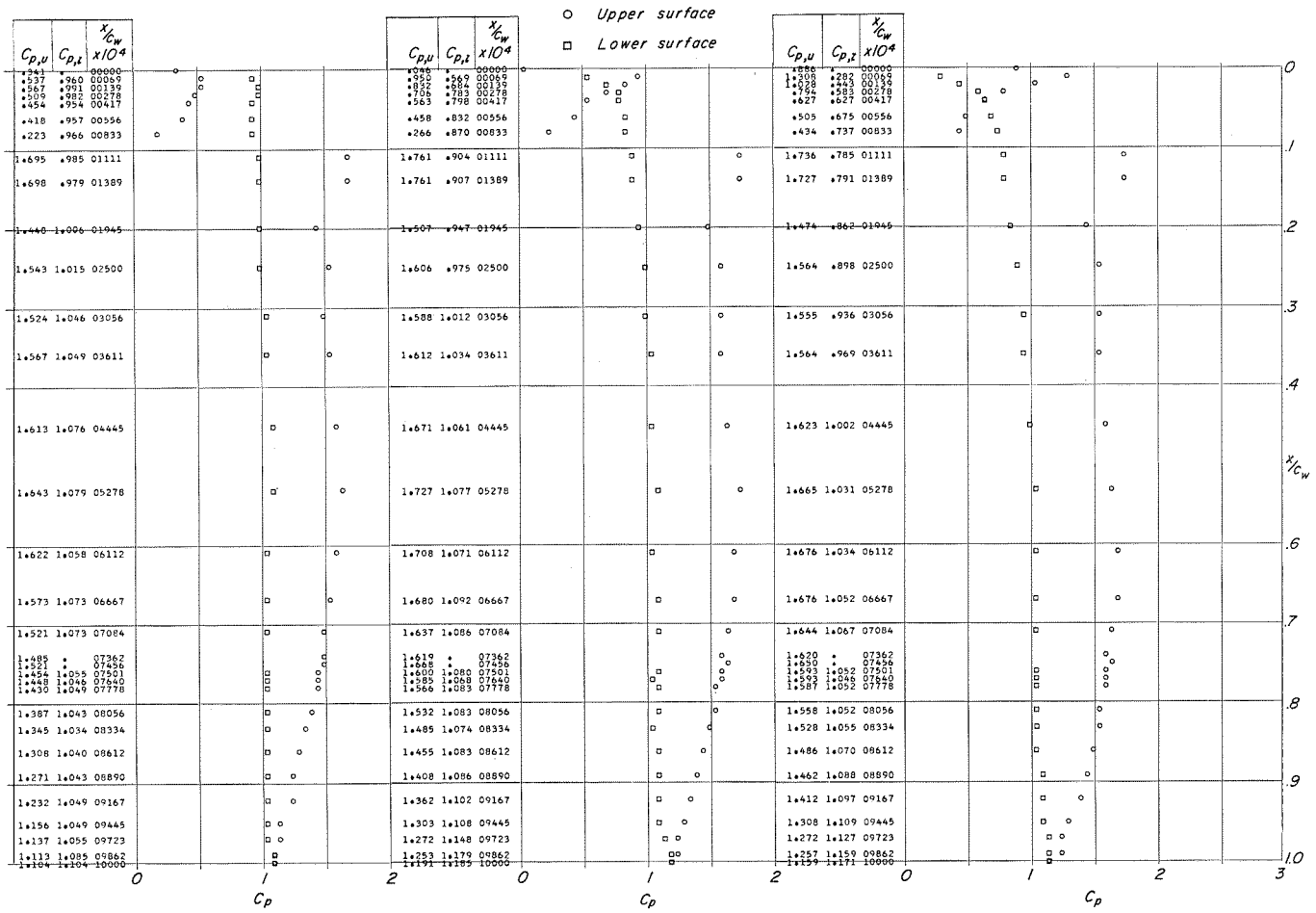
Figure 14.- Concluded.



(a) $\alpha = -4^\circ$.

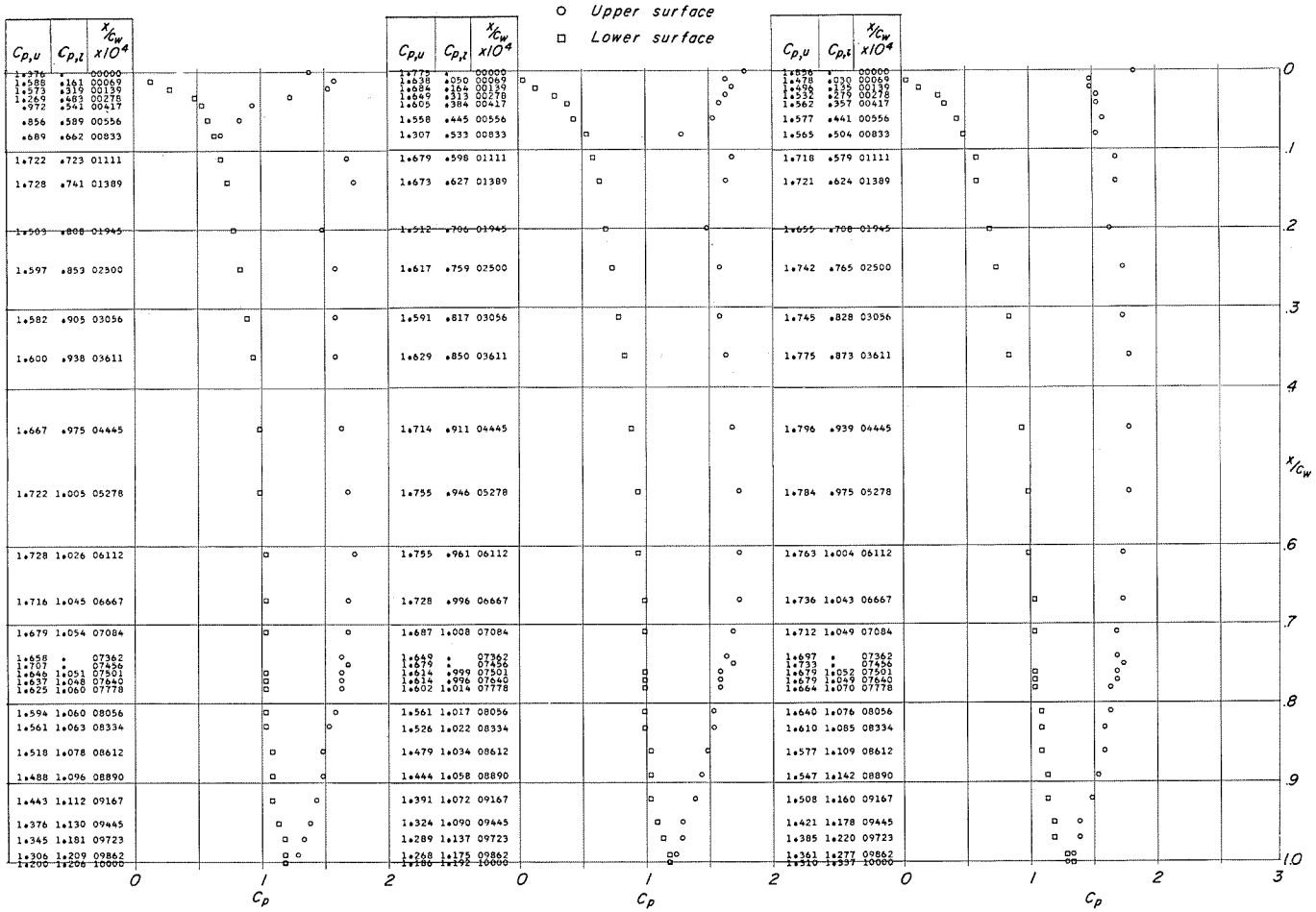
(b) $\alpha = 0^\circ$.

Figure 15.- Chordwise pressure distribution over model. $\delta_N = 0^\circ$; $\delta_f = 0^\circ$; half-span outboard spoiler hinged at 0.10c; tabulated data of points plotted to left of plot.



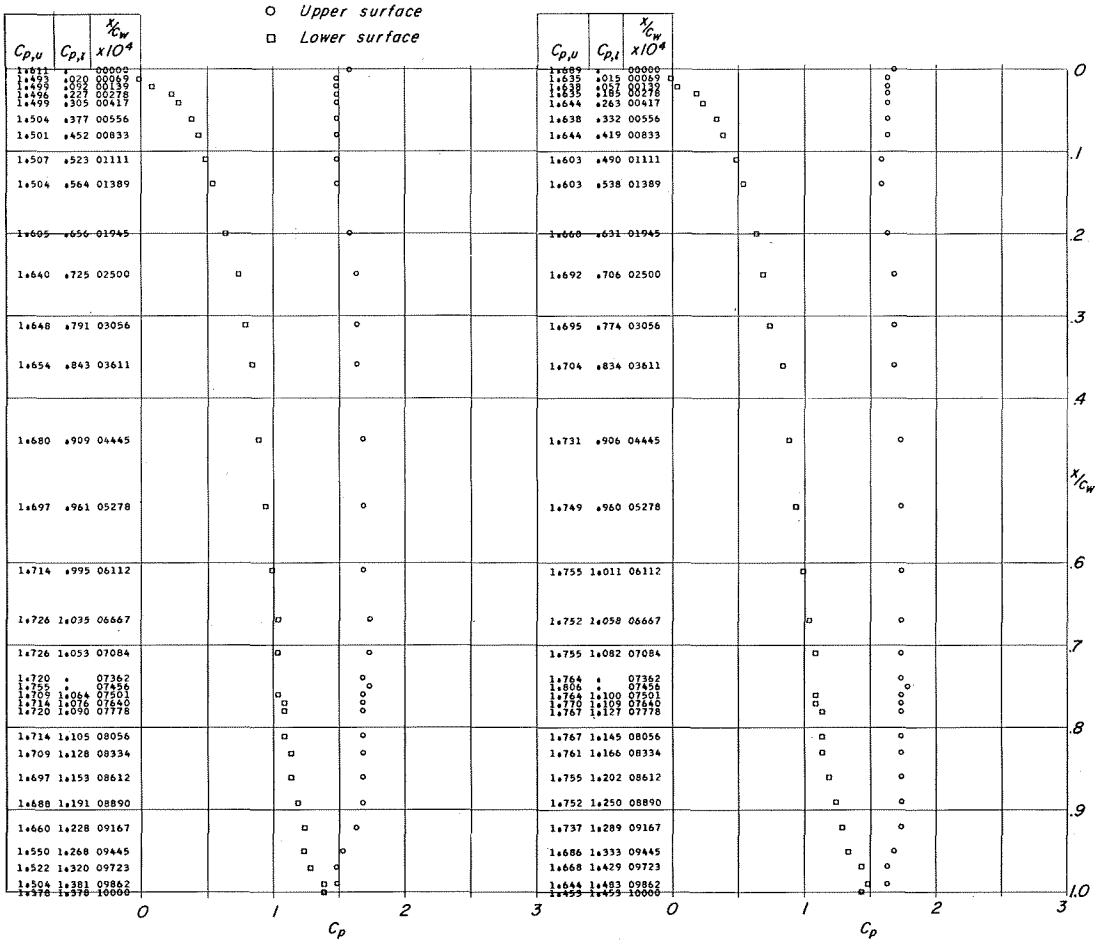
(c) $\alpha = 4^\circ$. (d) $\alpha = 6^\circ$. (e) $\alpha = 8^\circ$.

Figure 15.- Continued.



(f) $\alpha = 10^\circ$. (g) $\alpha = 12^\circ$. (h) $\alpha = 14^\circ$.

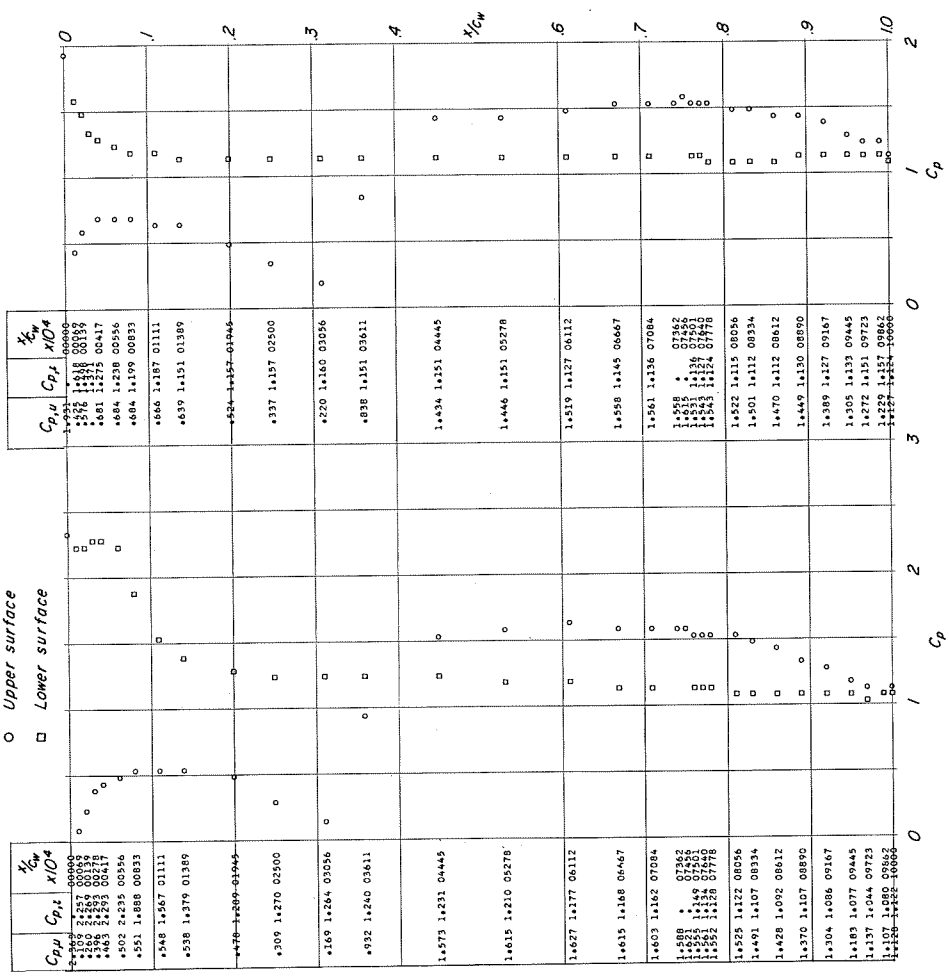
Figure 15.- Continued.



(i) $\alpha = 16^\circ$.

(j) $\alpha = 18^\circ$.

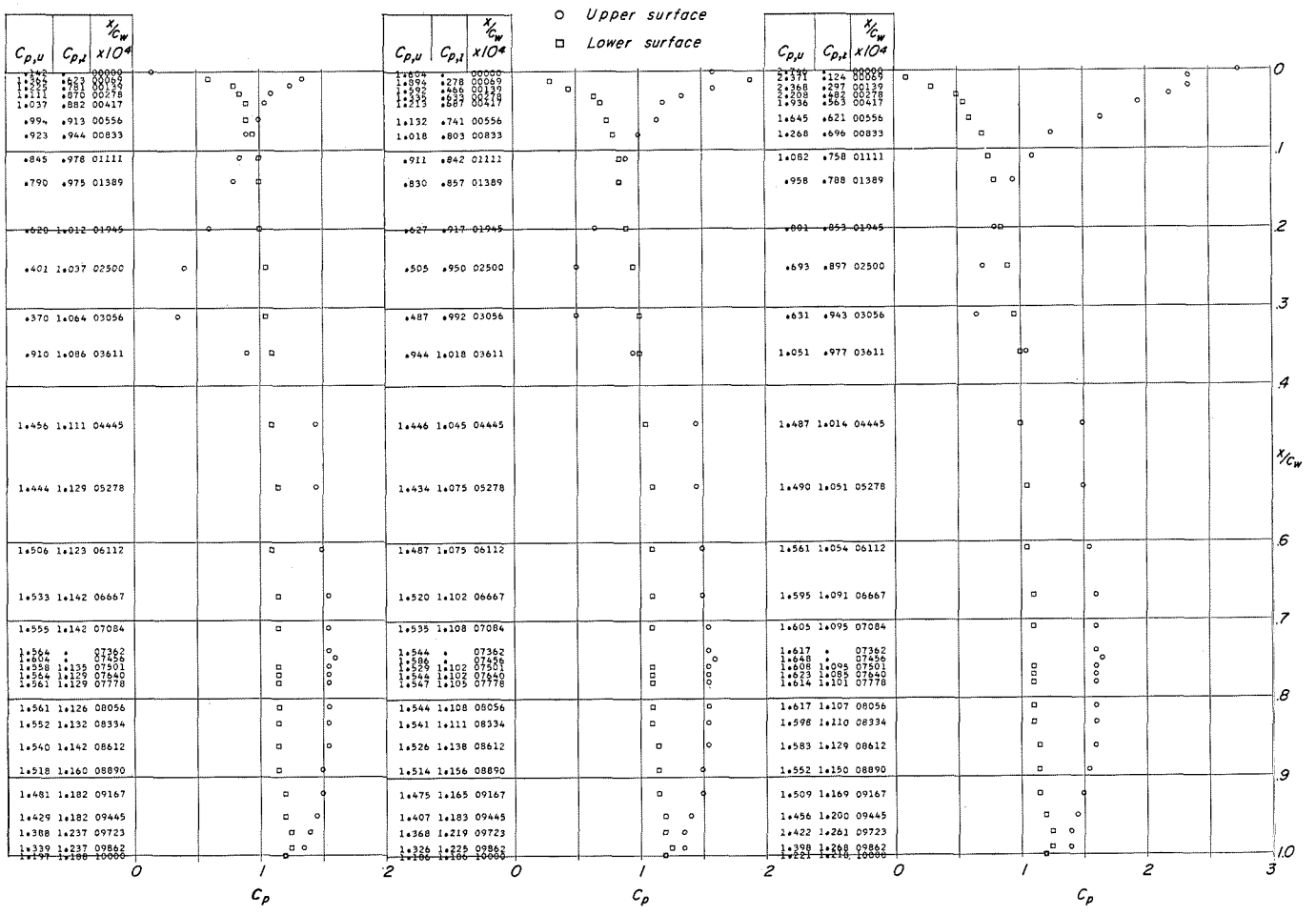
Figure 15.- Concluded.



(a) $\alpha = -4^\circ$.

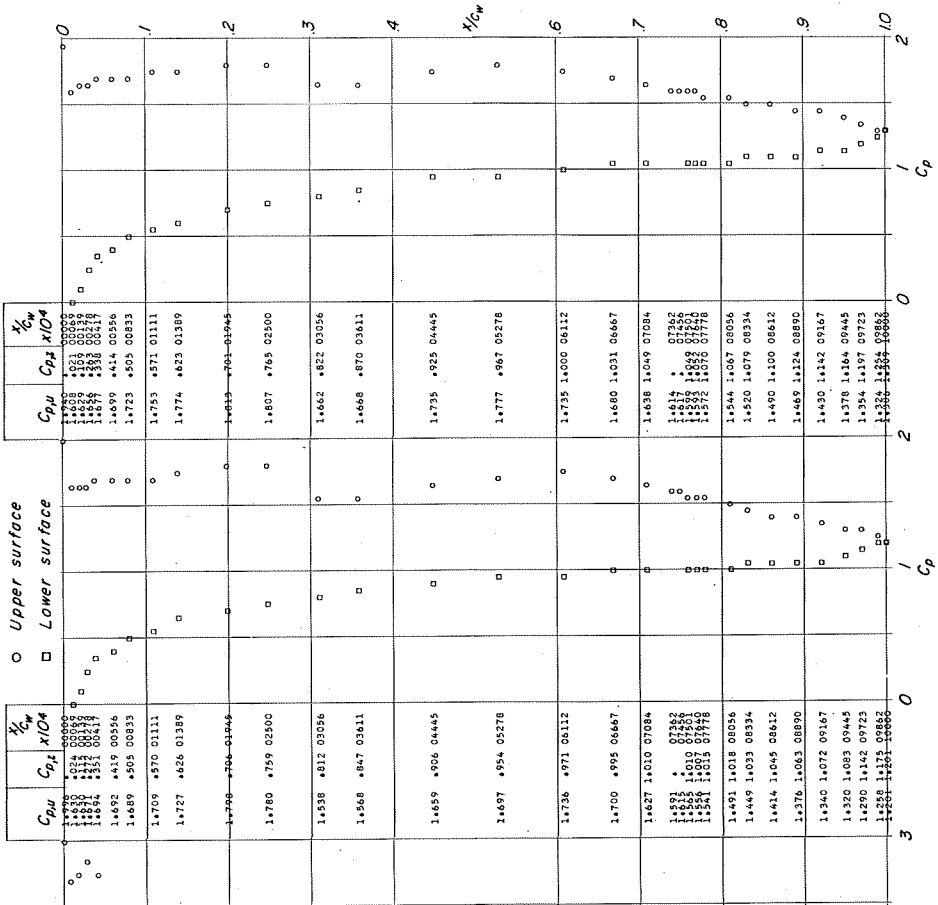
(b) $\alpha = 0^\circ$.

Figure 16.- Chordwise pressure distribution over model. $\delta_N = 0^\circ$; $\delta_f = 0^\circ$; half-span outboard spoiler hinged at 0.30c; tabulated data of points plotted to left of plot.



(c) $\alpha = 4^\circ$. (d) $\alpha = 6^\circ$. (e) $\alpha = 8^\circ$.

Figure 16.- Continued.

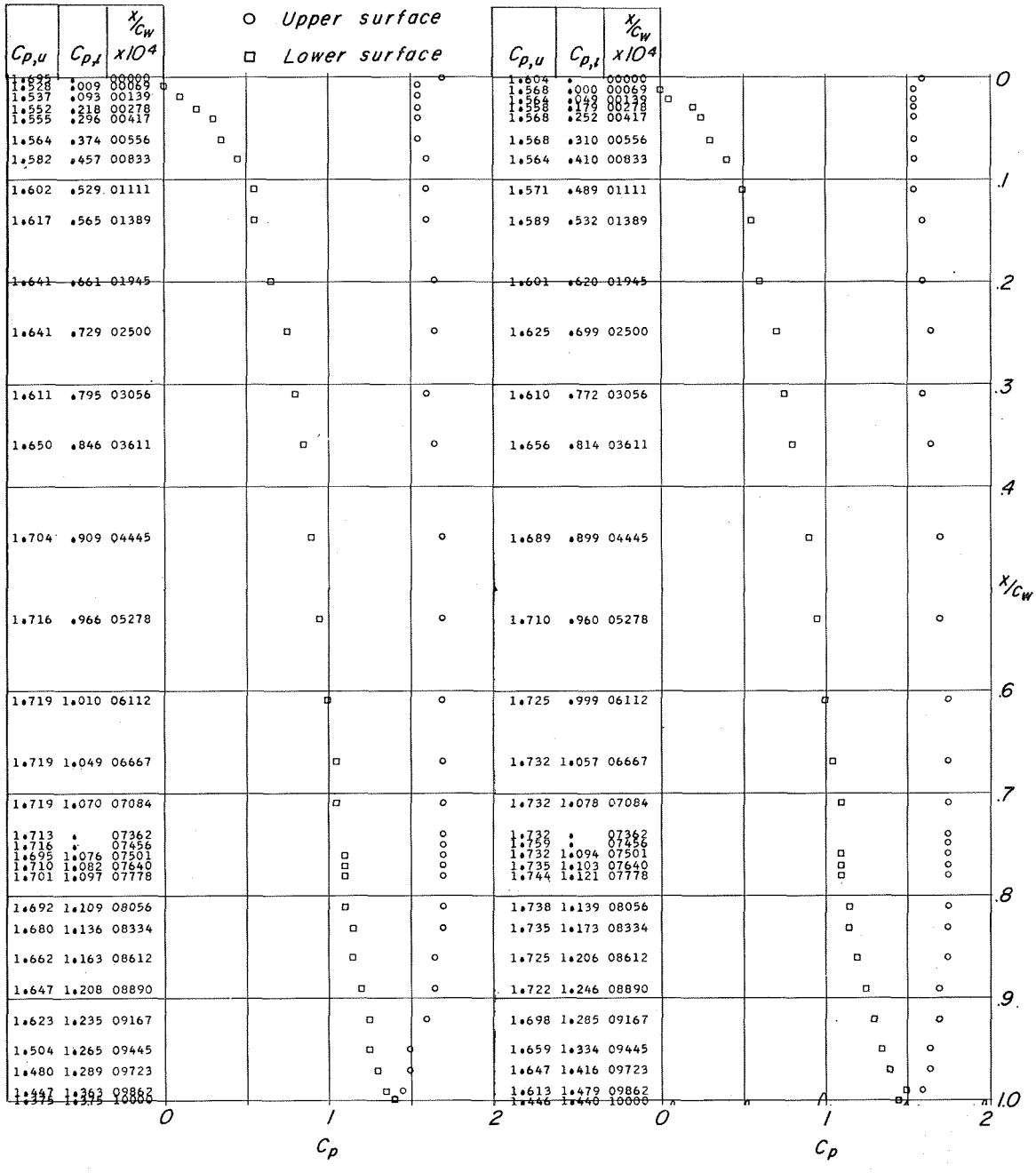


(f) $\alpha = 10°$.

(g) $\alpha = 12°$.

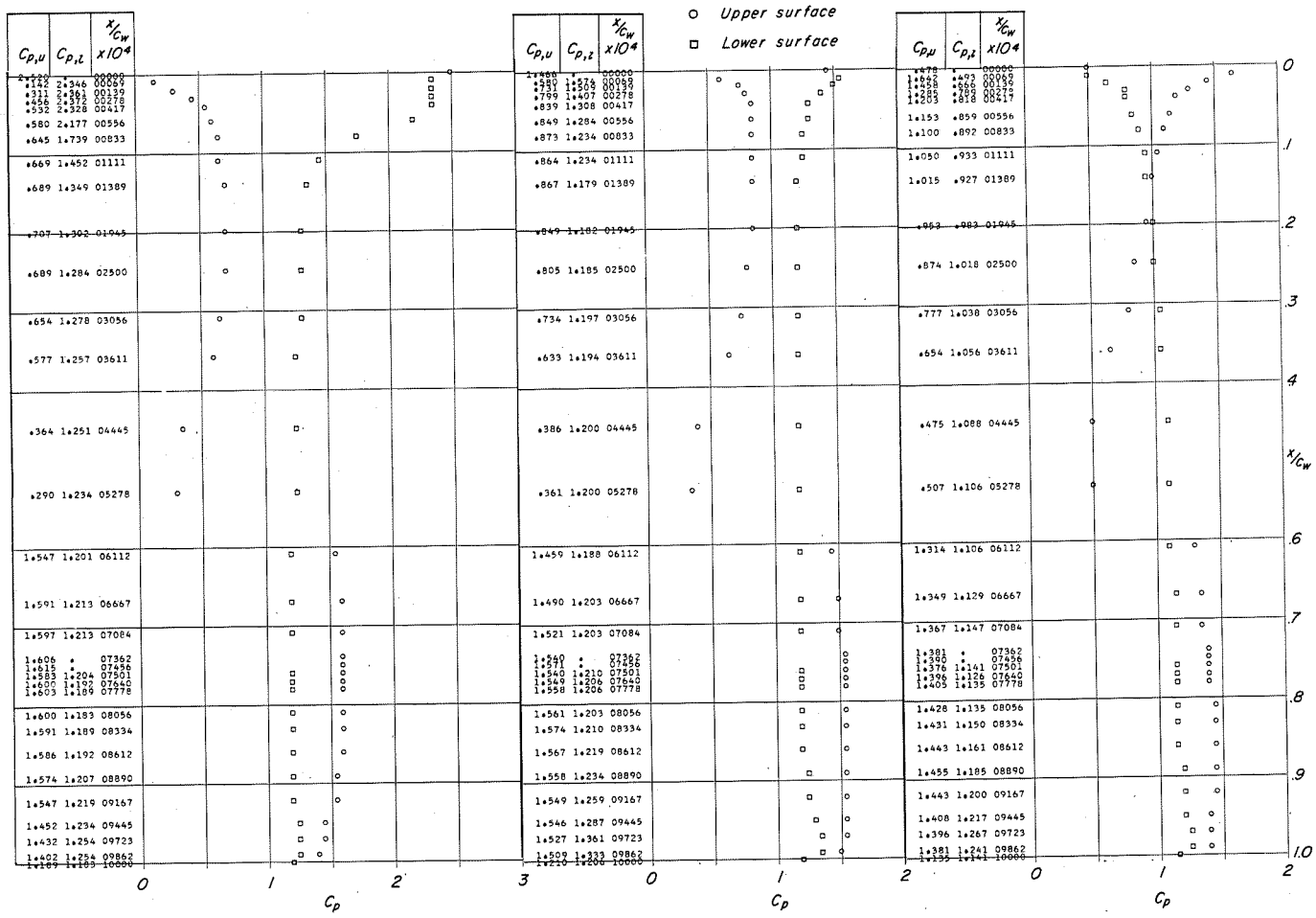
(h) $\alpha = 14°$.

Figure 16.- Continued.



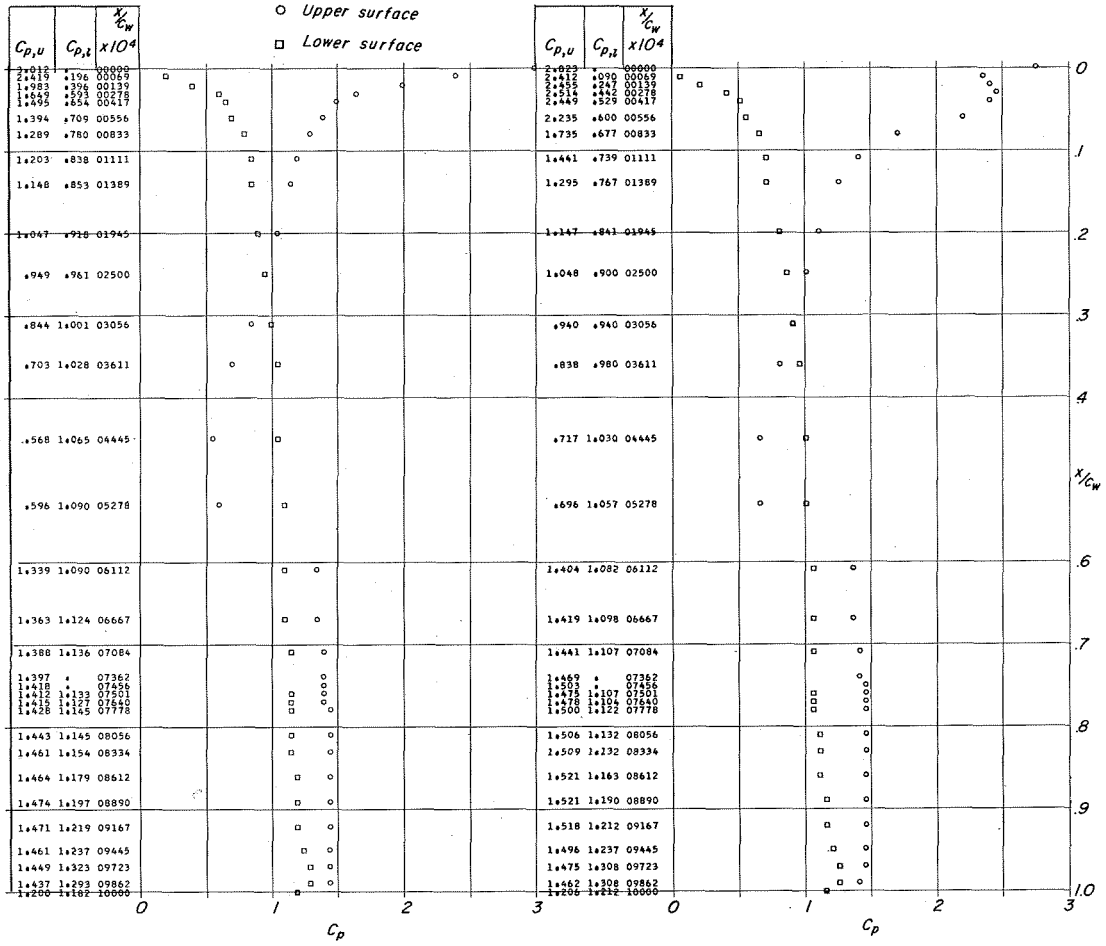
(i) $\alpha = 16^\circ$. (j) $\alpha = 18^\circ$.

Figure 16.- Concluded.



(a) $\alpha = -4^\circ$. (b) $\alpha = 0^\circ$. (c) $\alpha = 4^\circ$.

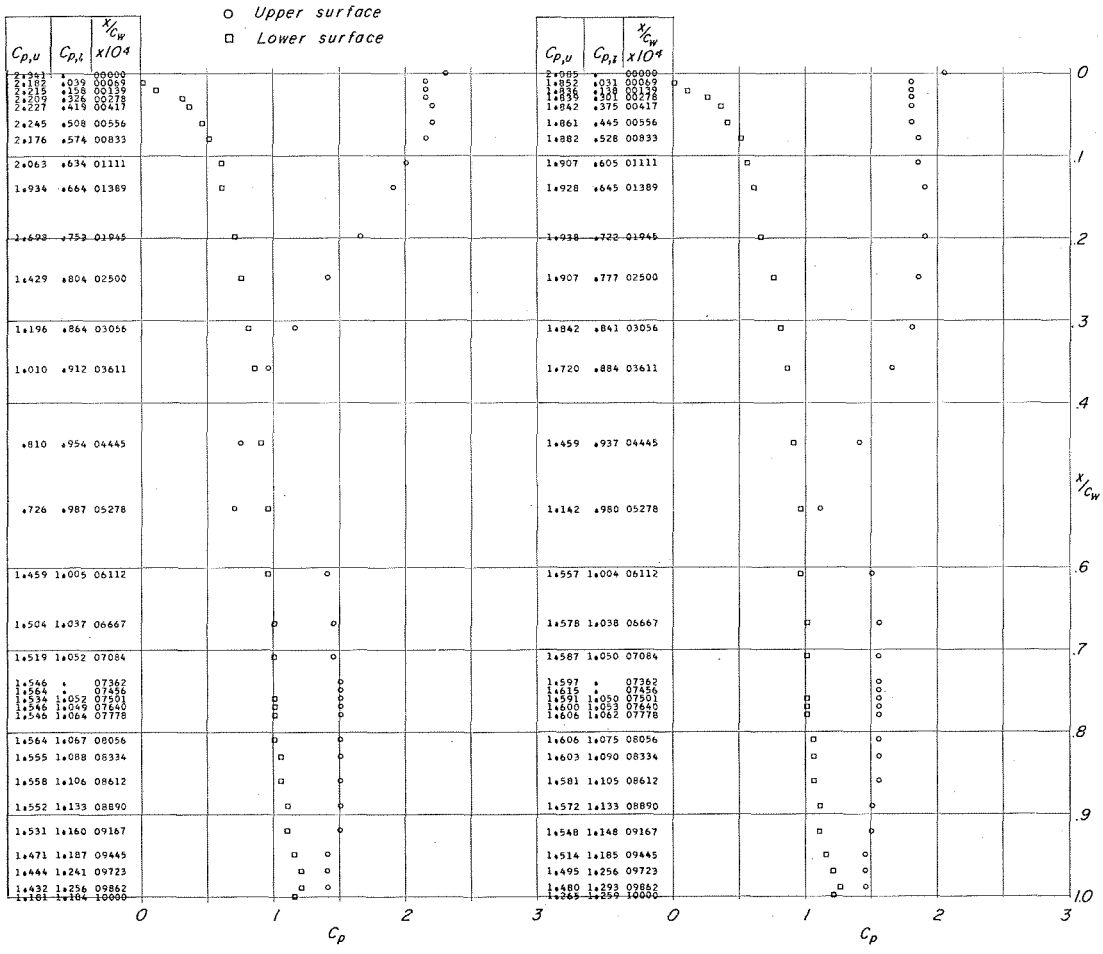
Figure 17.- Chordwise pressure distribution over model. $\delta_N = 0^\circ$; $\delta_f = 0^\circ$; half-span outboard spoiler hinged at 0.50c; tabulated data of points plotted to left of plot.



(d) $\alpha = 6^\circ$.

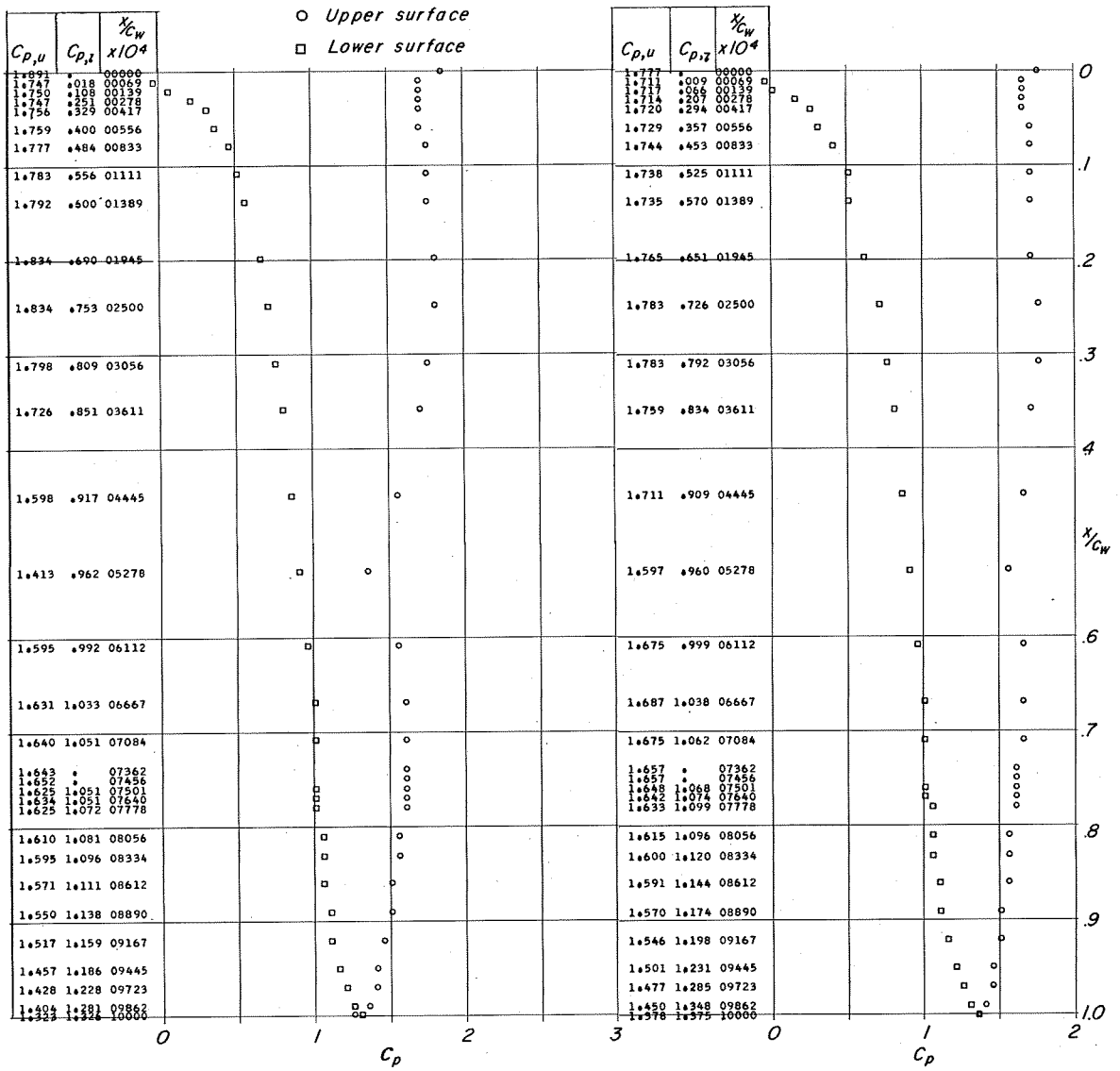
(e) $\alpha = 8^\circ$.

Figure 17.- Continued.



(f) $\alpha = 10^\circ$. (g) $\alpha = 12^\circ$.

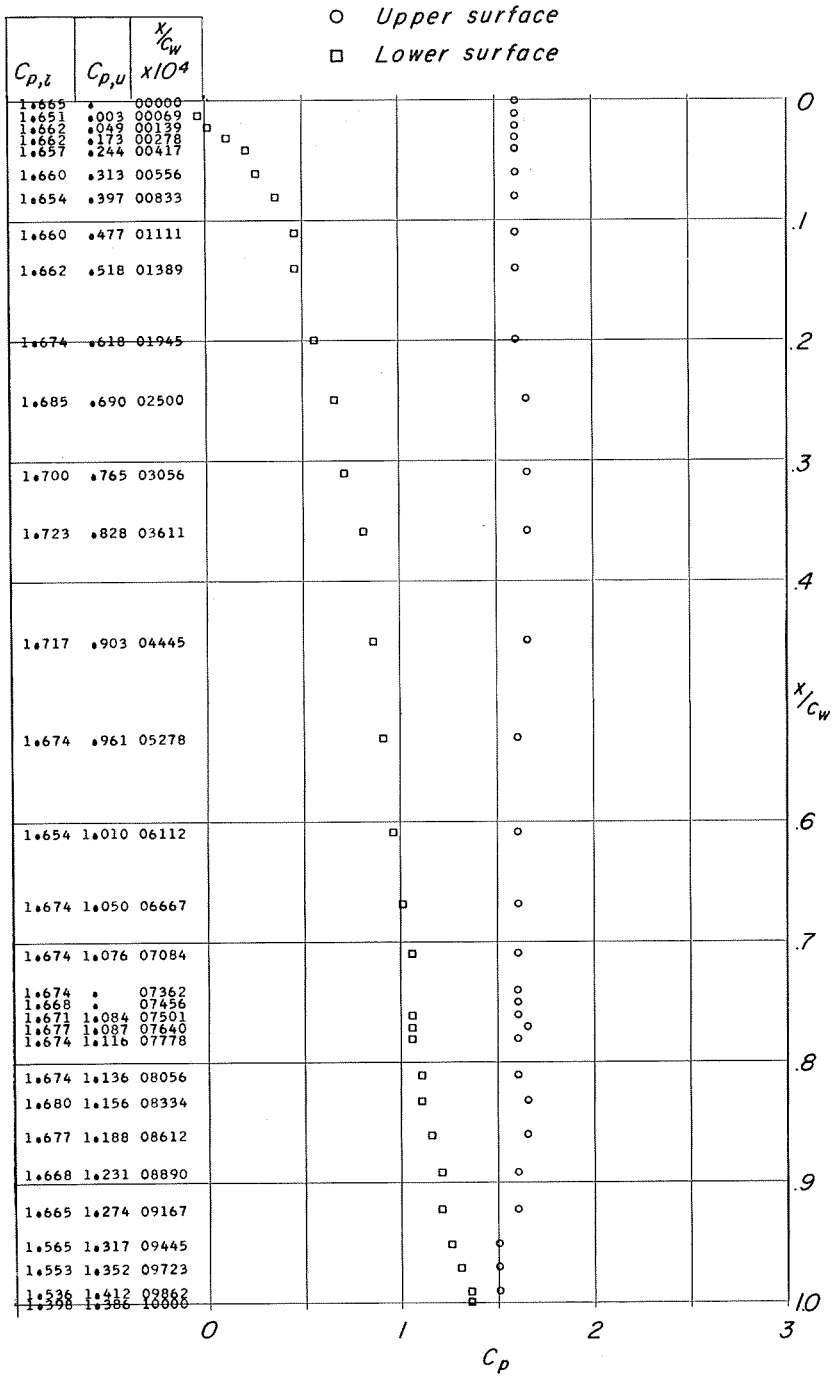
Figure 17.- Continued.



(h) $\alpha = 14^\circ$.

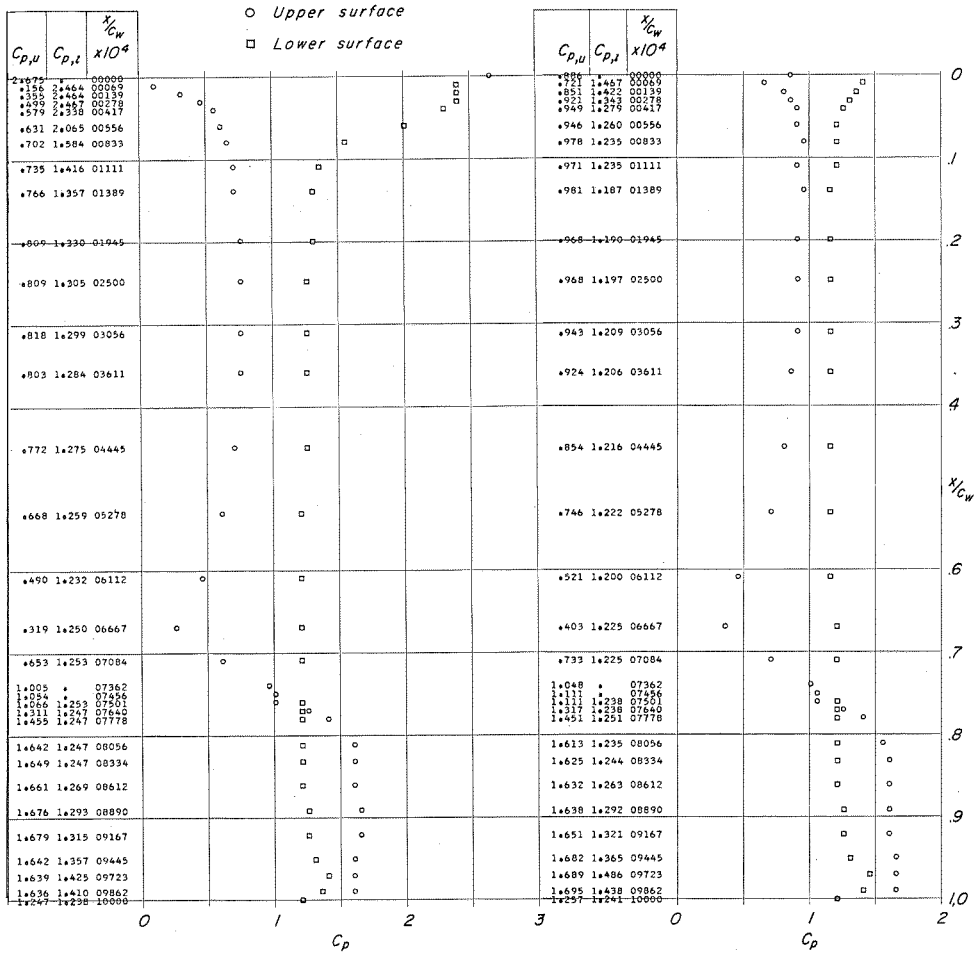
(i) $\alpha = 16^\circ$.

Figure 17.- Continued.



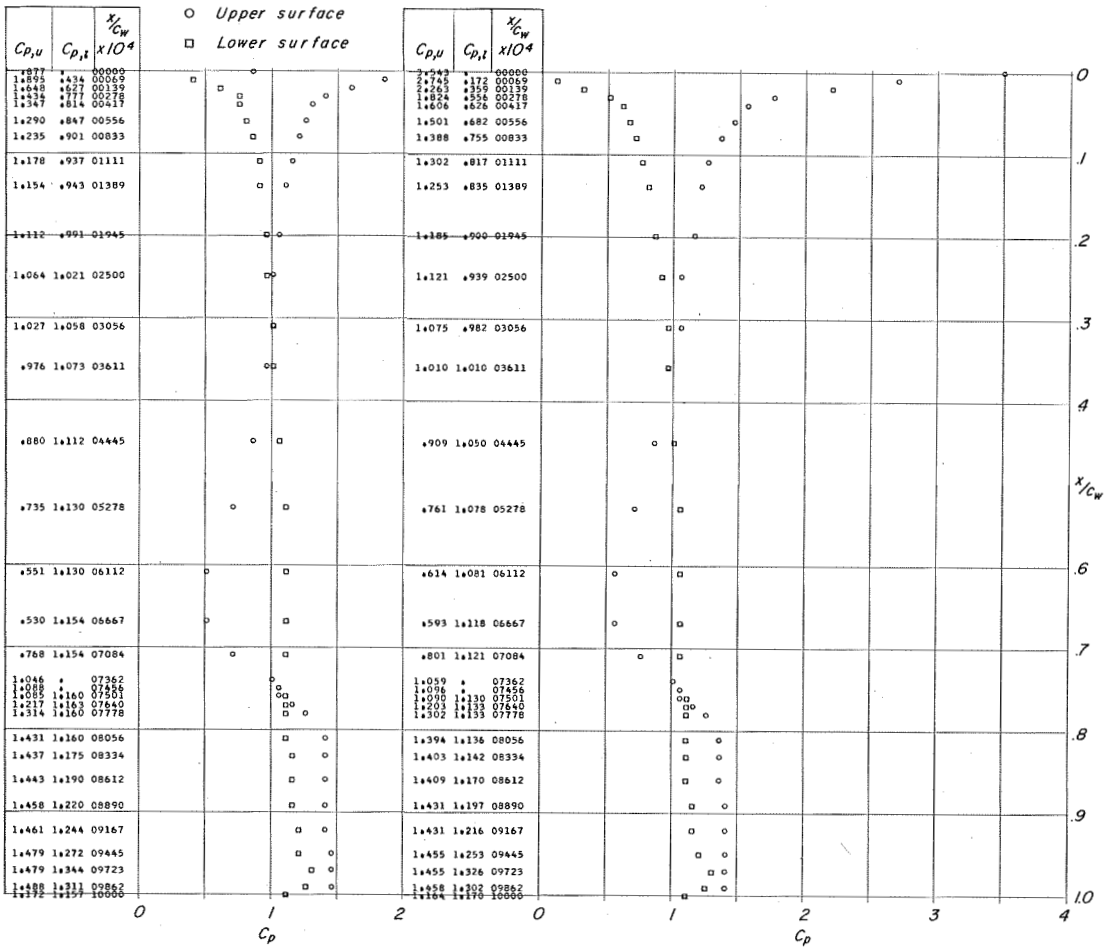
(j) $\alpha = 18^\circ$.

Figure 17.- Concluded.



(a) $\alpha = -4^\circ$. (b) $\alpha = 0^\circ$.

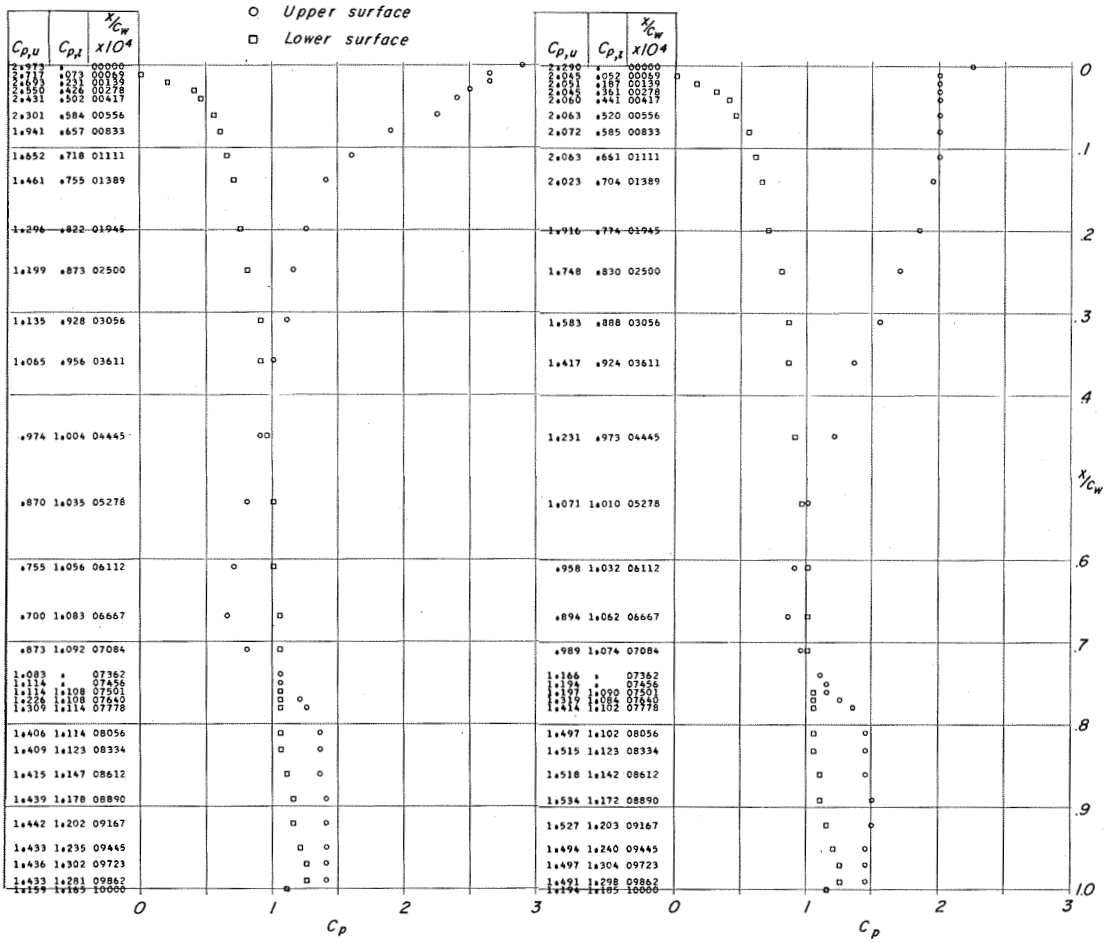
Figure 18.- Chordwise pressure distribution over model. $\delta_N = 0^\circ$; $\delta_f = 0^\circ$; half-span outboard spoiler hinged at 0.70c; tabulated data of points plotted to left of plot.



(c) $\alpha = 4^\circ$.

(d) $\alpha = 6^\circ$.

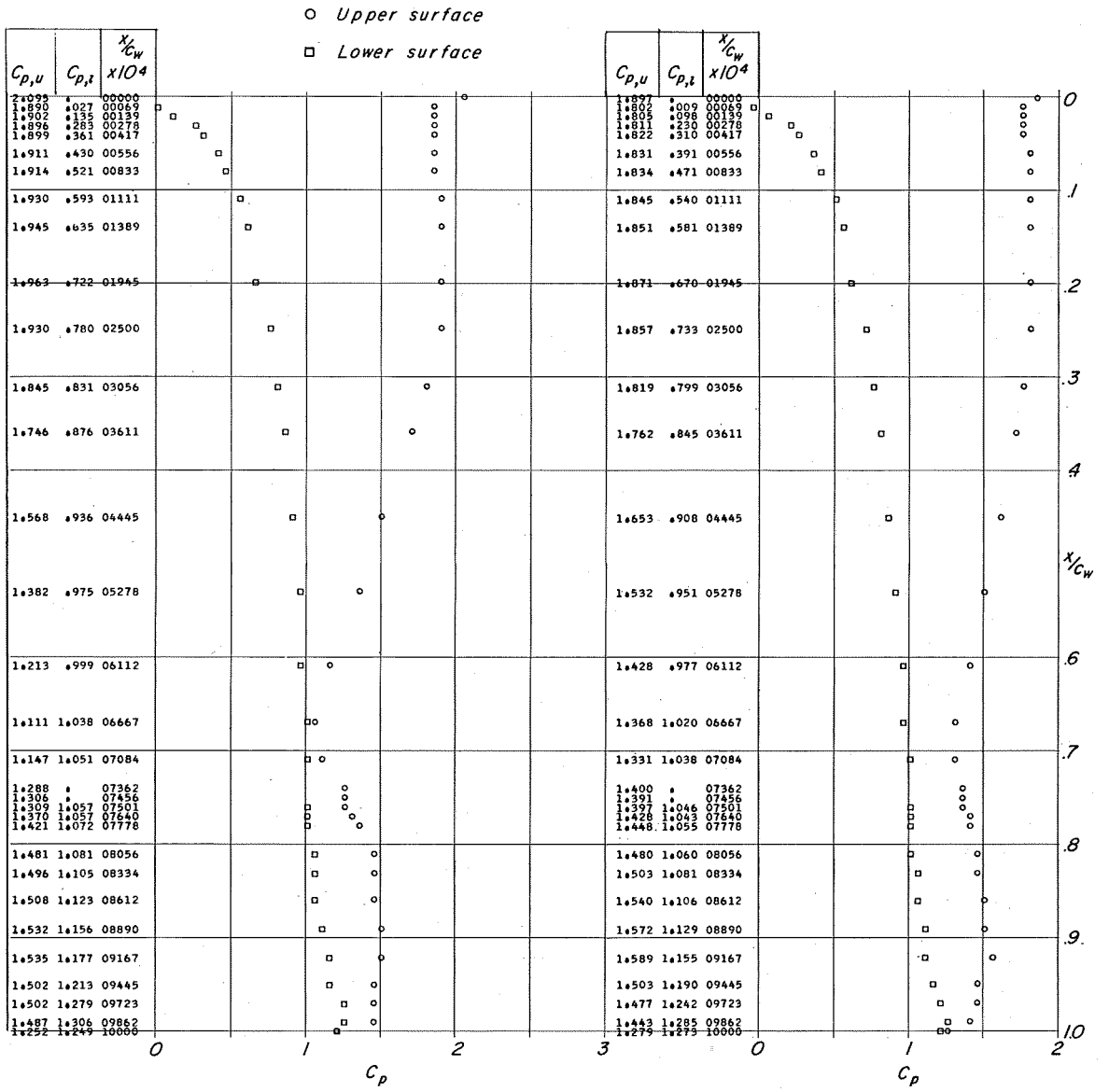
Figure 18.- Continued.



(e) $\alpha = 8^\circ$.

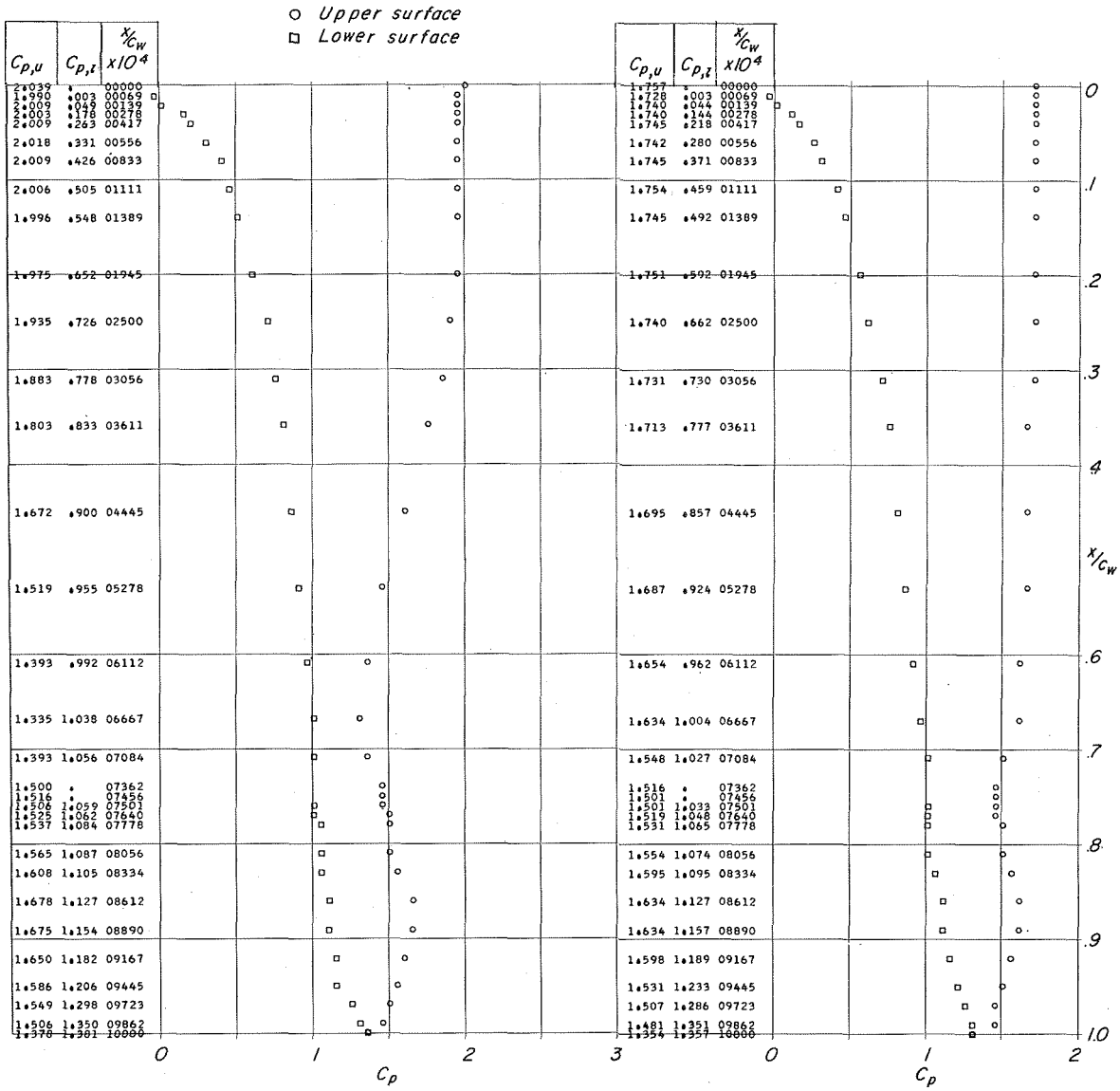
(f) $\alpha = 10^\circ$.

Figure 18.- Continued.



(g) $\alpha = 12^\circ$. (h) $\alpha = 14^\circ$.

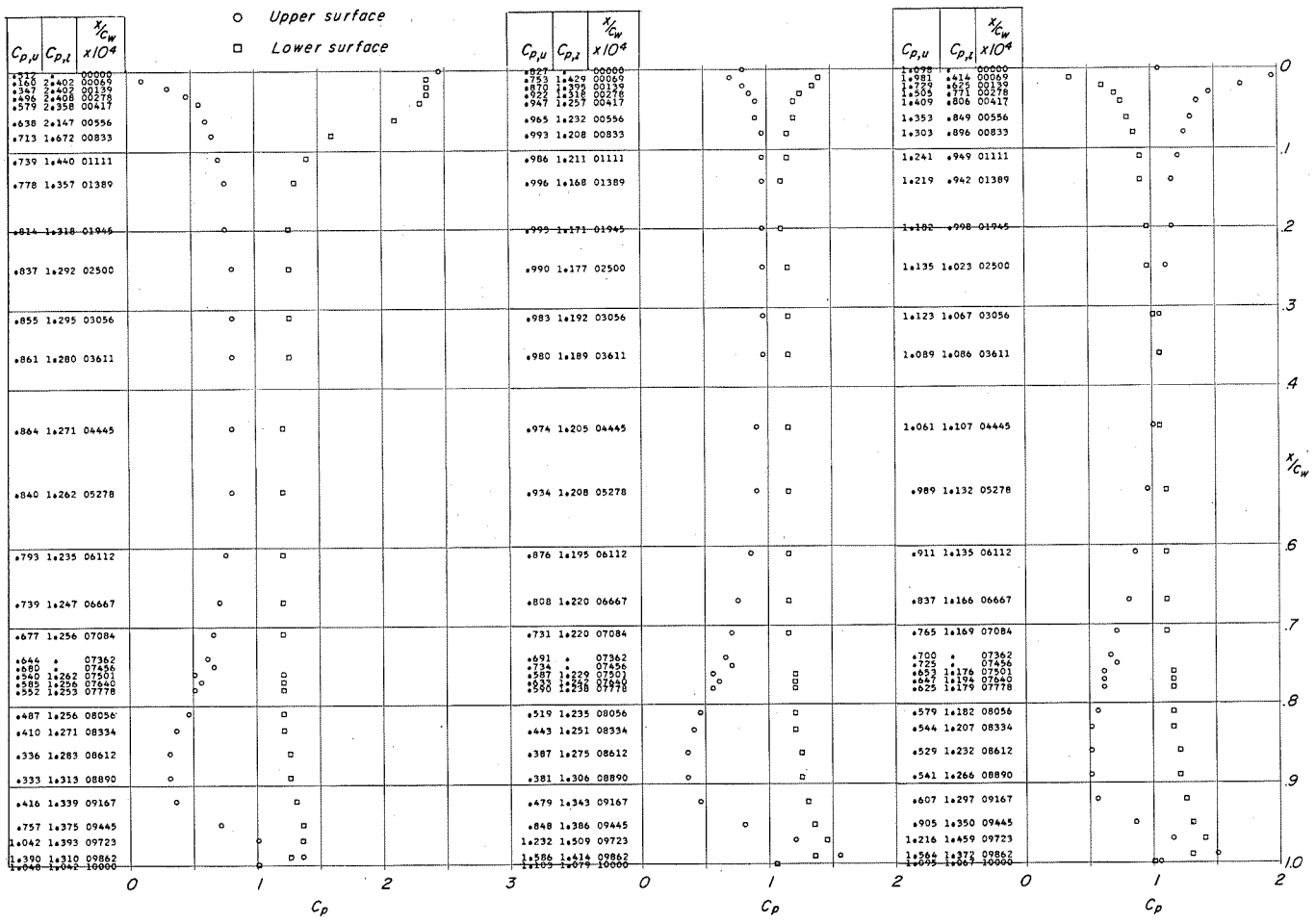
Figure 18.- Continued.



(i) $\alpha = 16^\circ$.

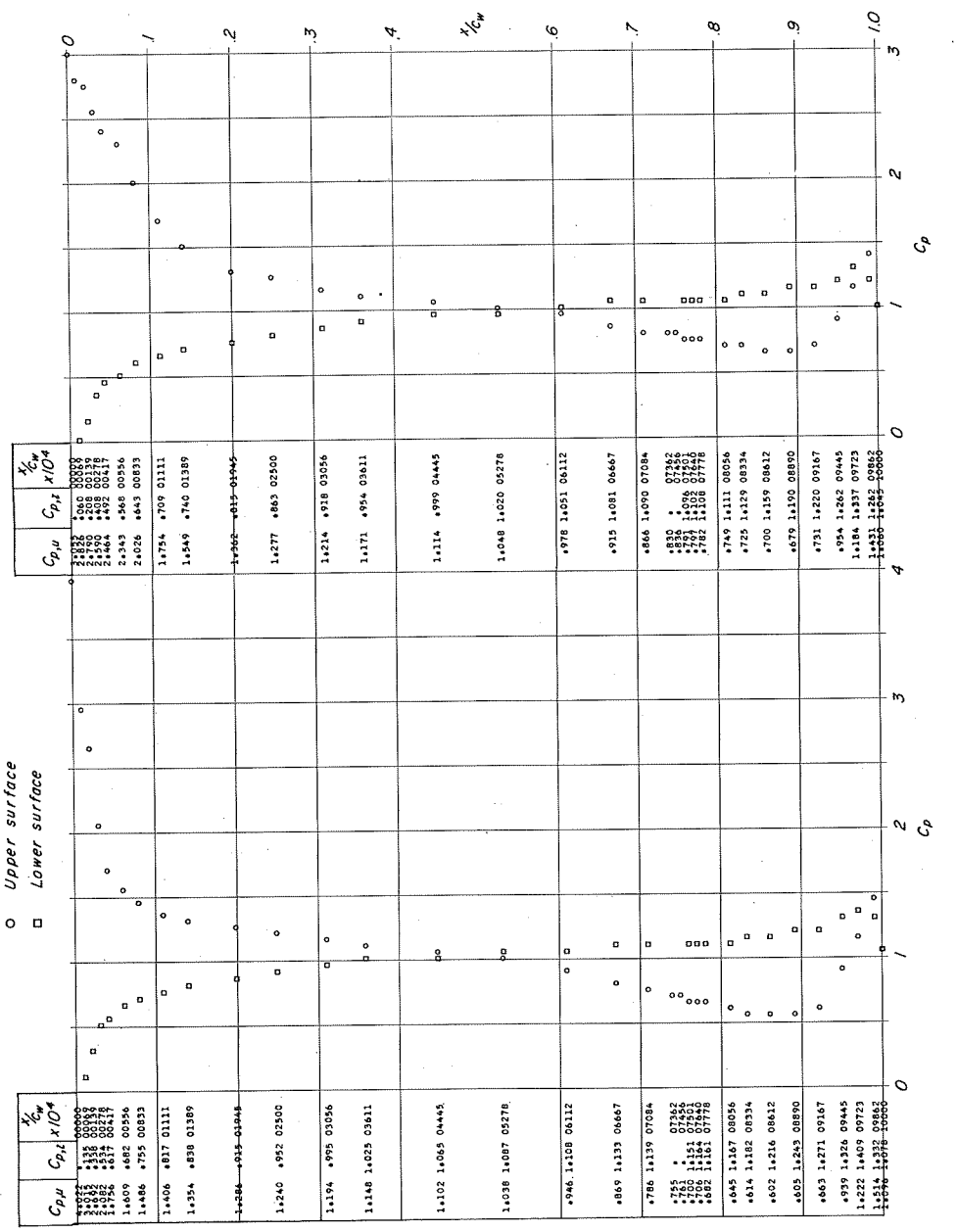
(j) $\alpha = 18^\circ$.

Figure 18.- Concluded.



(a) $\alpha = -4^\circ$. (b) $\alpha = 0^\circ$. (c) $\alpha = 4^\circ$.

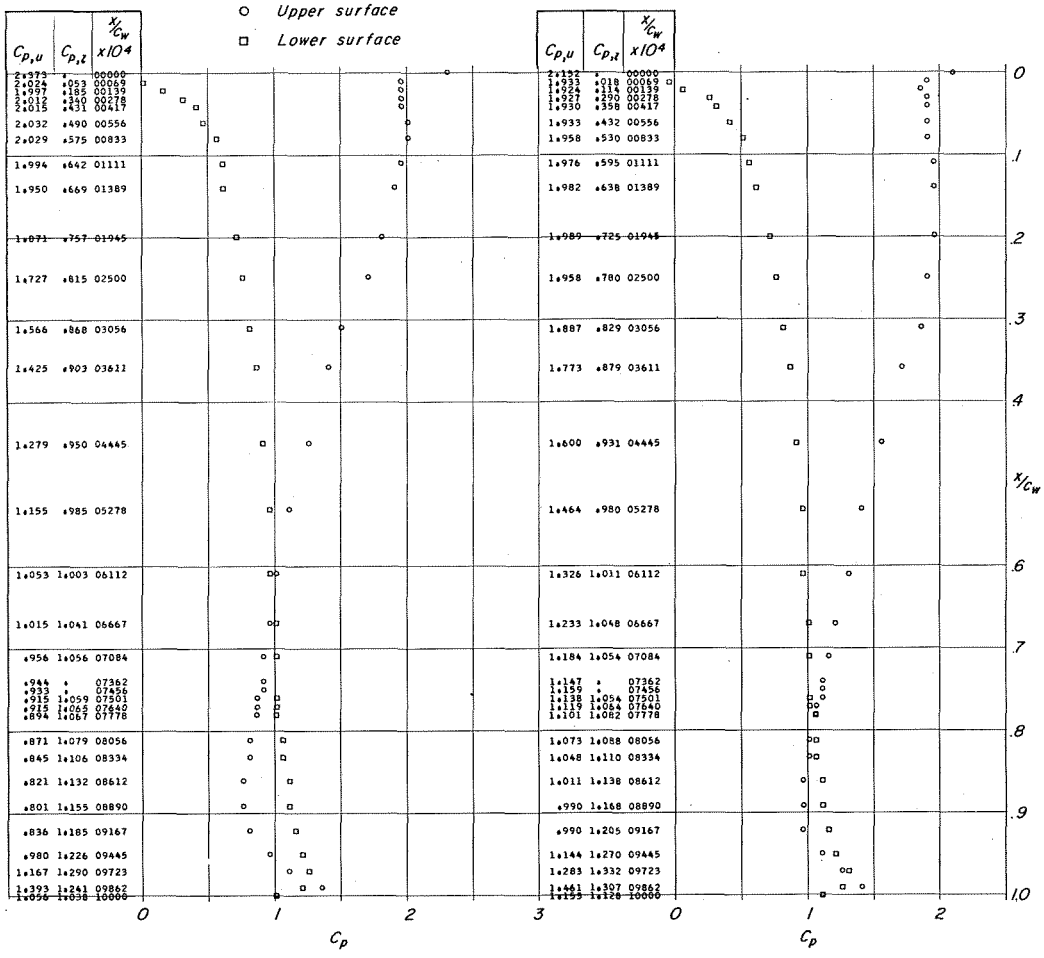
Figure 19.- Chordwise pressure distribution over model. $\delta_N = 0^\circ$; $\delta_f = 0^\circ$; half-span outboard spoiler hinged at 0.90c; tabulated data of points plotted to left of plot.



(d) $\alpha = 6°$.

(e) $\alpha = 8°$.

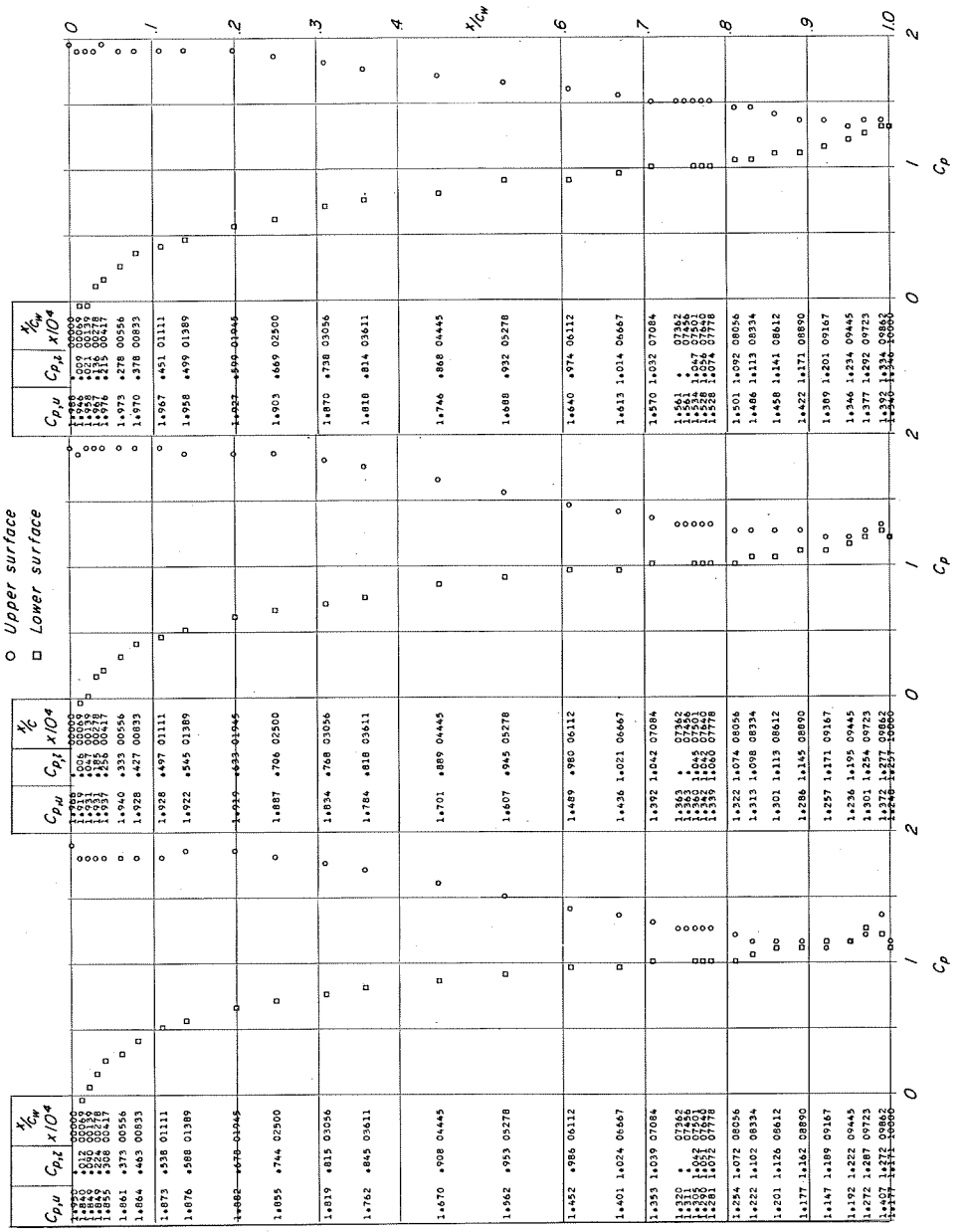
Figure 19.- Continued.



(f) $\alpha = 10^\circ$.

(g) $\alpha = 12^\circ$.

Figure 19.- Continued.

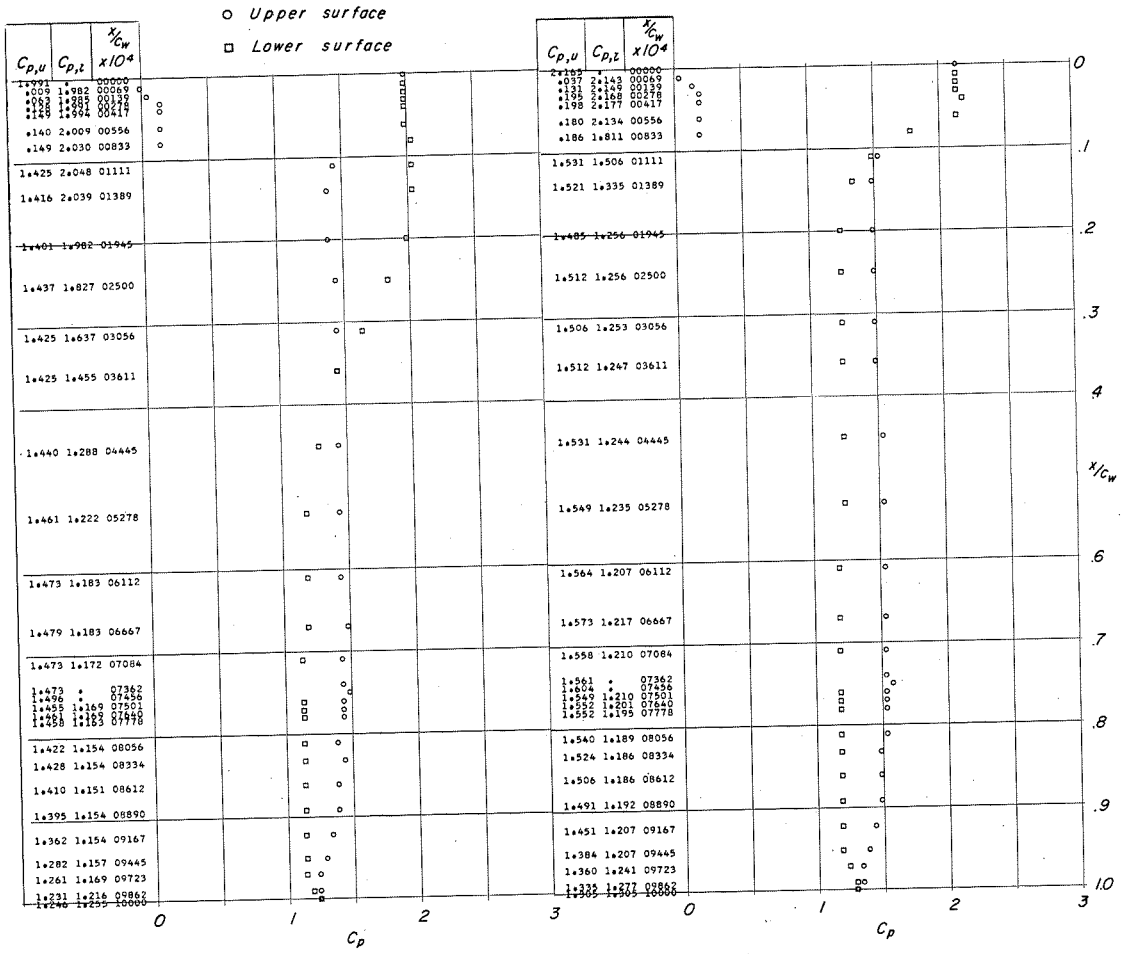


(h) $\alpha = 14^\circ$.

(i) $\alpha = 16^\circ$.

(j) $\alpha = 18^\circ$.

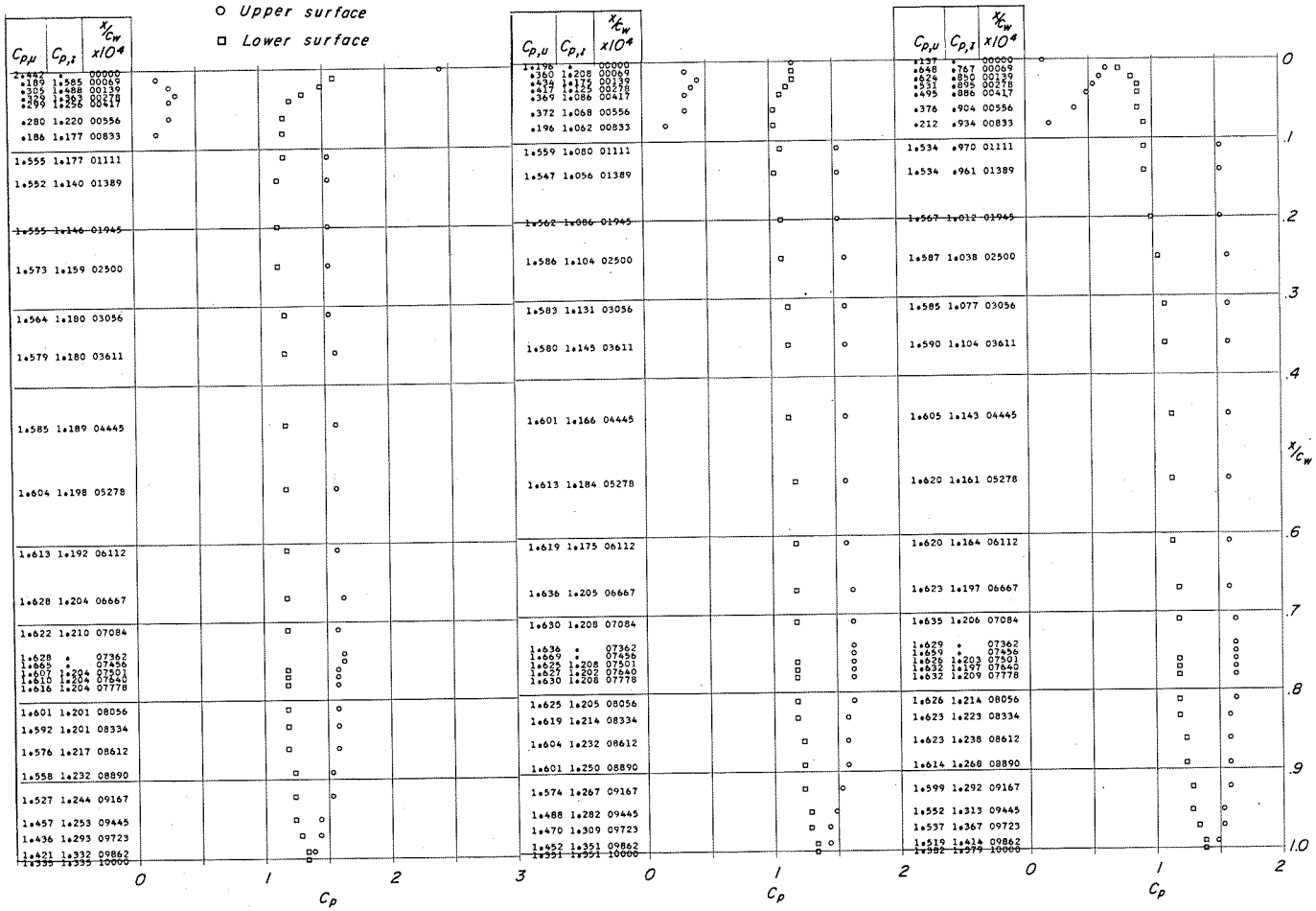
Figure 19.- Concluded.



(a) $\alpha = -4^\circ$.

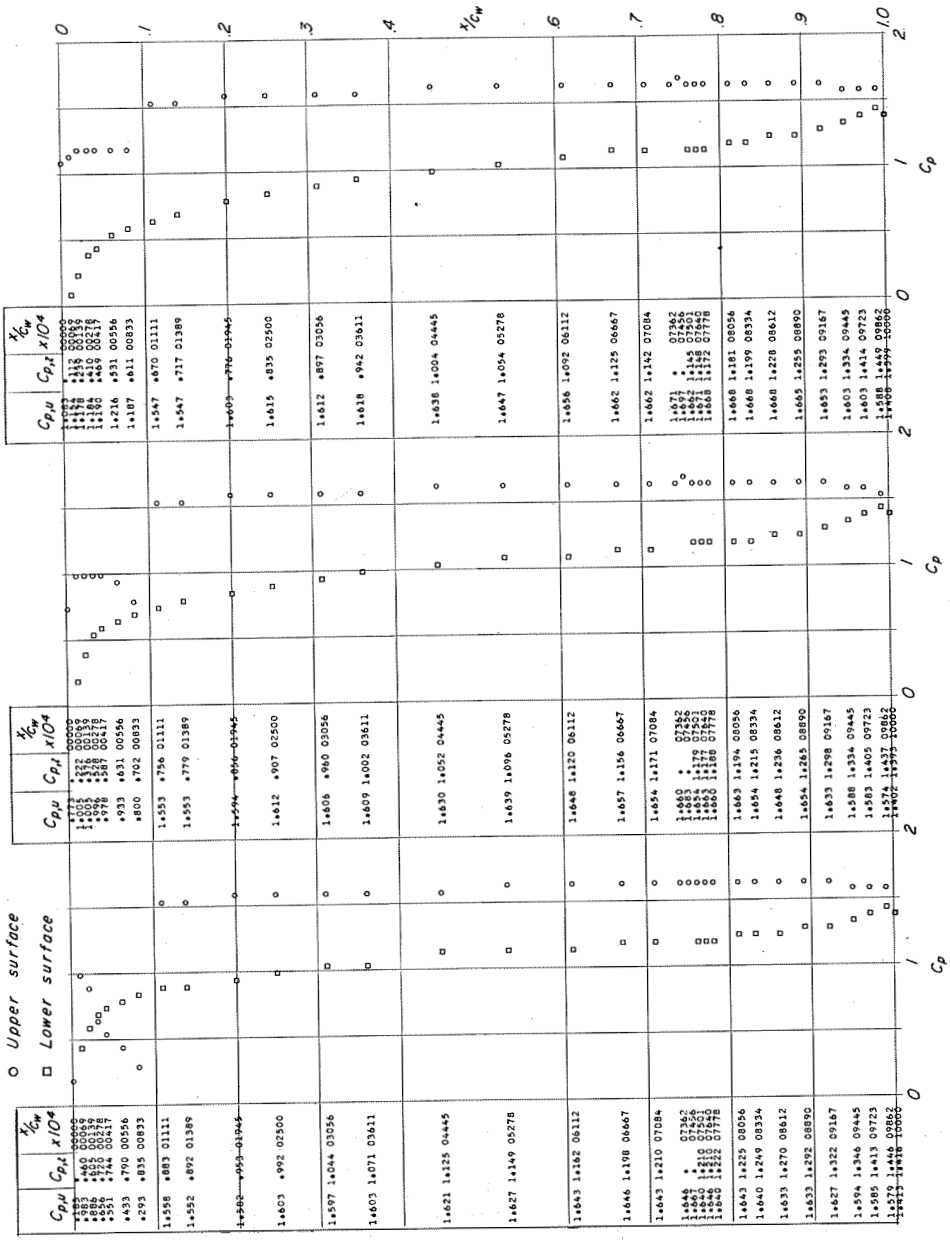
(b) $\alpha = 0^\circ$.

Figure 20.- Chordwise pressure distribution over model. $\delta_N = 0^\circ$; $\delta_f = 0^\circ$; full-span spoiler hinged at 0.10c; tabulated data of points plotted to left of plot.



(c) $\alpha = 4^\circ$. (d) $\alpha = 6^\circ$. (e) $\alpha = 8^\circ$.

Figure 20.- Continued.

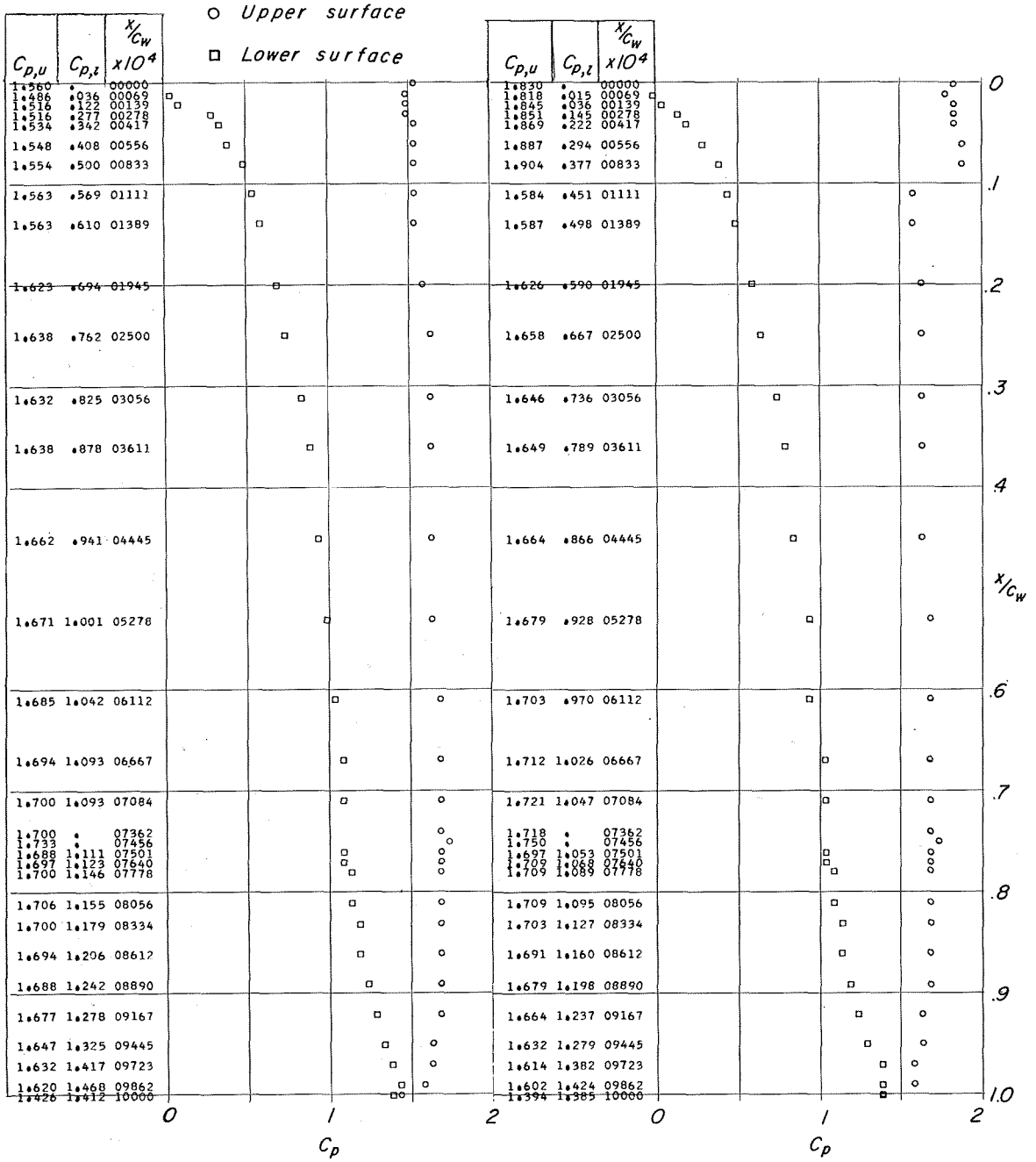


(f) $\alpha = 10^{\circ}$.

(g) $\alpha = 12^{\circ}$.

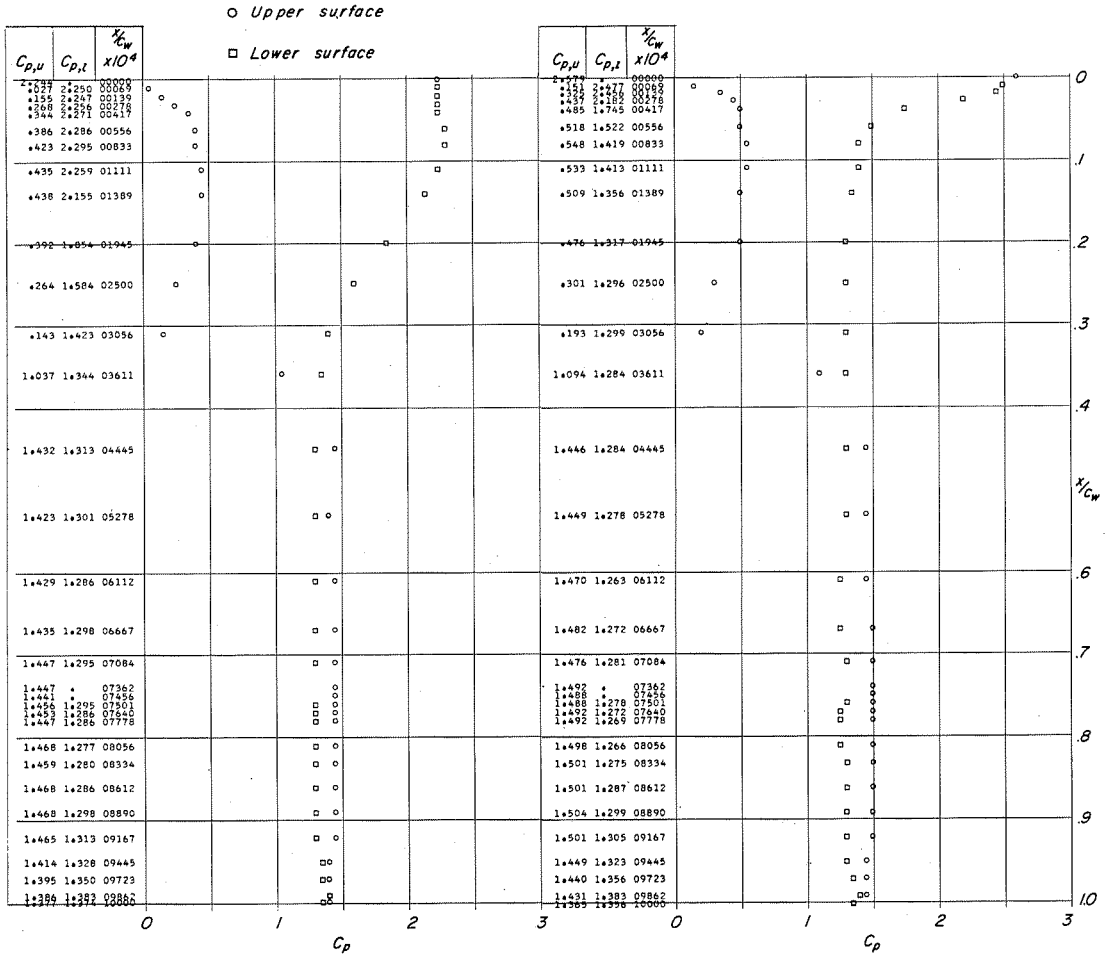
(h) $\alpha = 14^{\circ}$.

Figure 20.- Continued.



(i) $\alpha = 16^\circ$. (j) $\alpha = 18^\circ$.

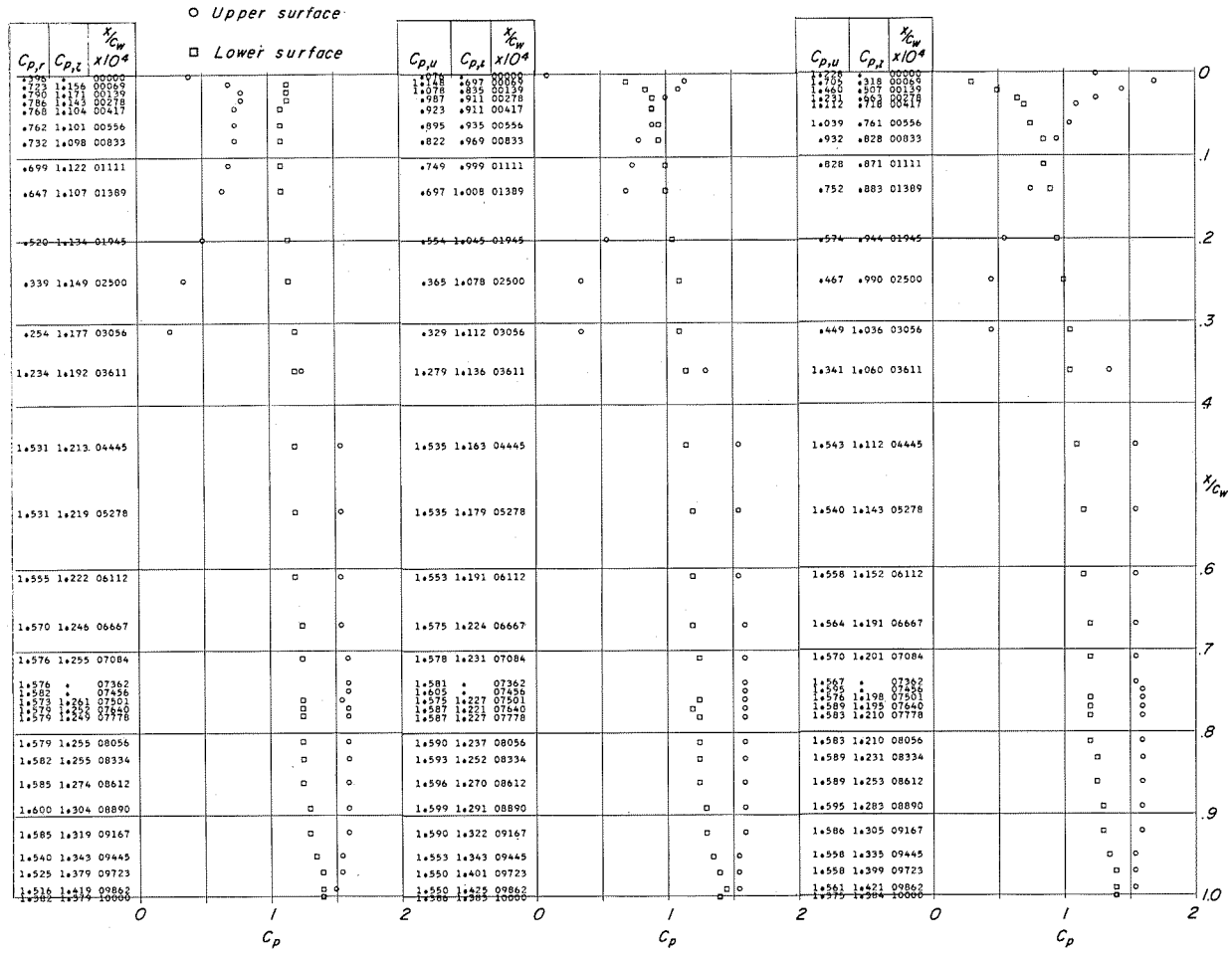
Figure 20.- Concluded.



(a) $\alpha = -4^\circ$.

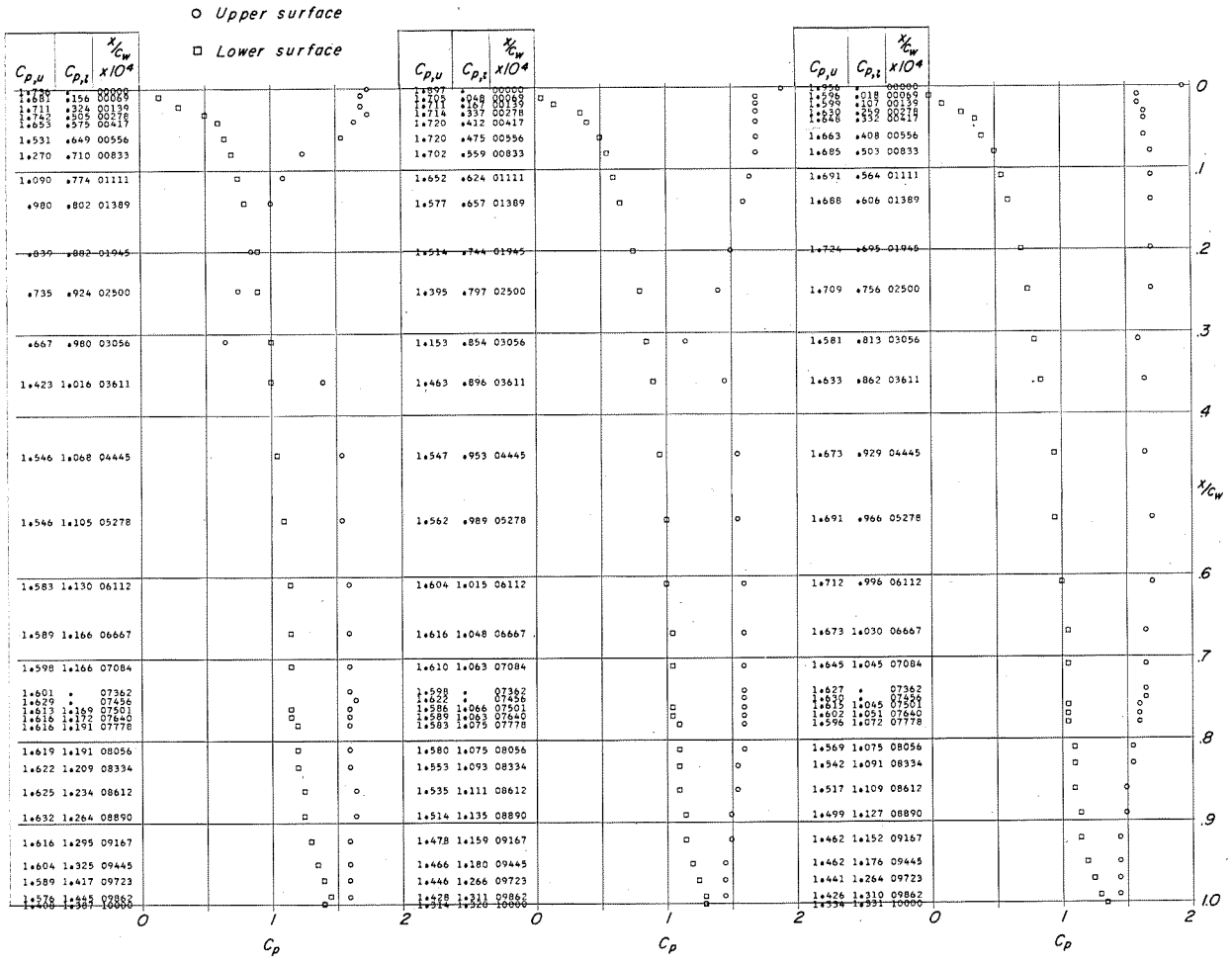
(b) $\alpha = 0^\circ$.

Figure 21.- Chordwise pressure distribution over model. $\delta_N = 0^\circ$; $\delta_f = 0^\circ$; full-span spoiler hinged at 0.30c; tabulated data of points plotted to left of plot.



(c) $\alpha = 4^\circ$. (d) $\alpha = 6^\circ$. (e) $\alpha = 8^\circ$.

Figure 21.- Continued.

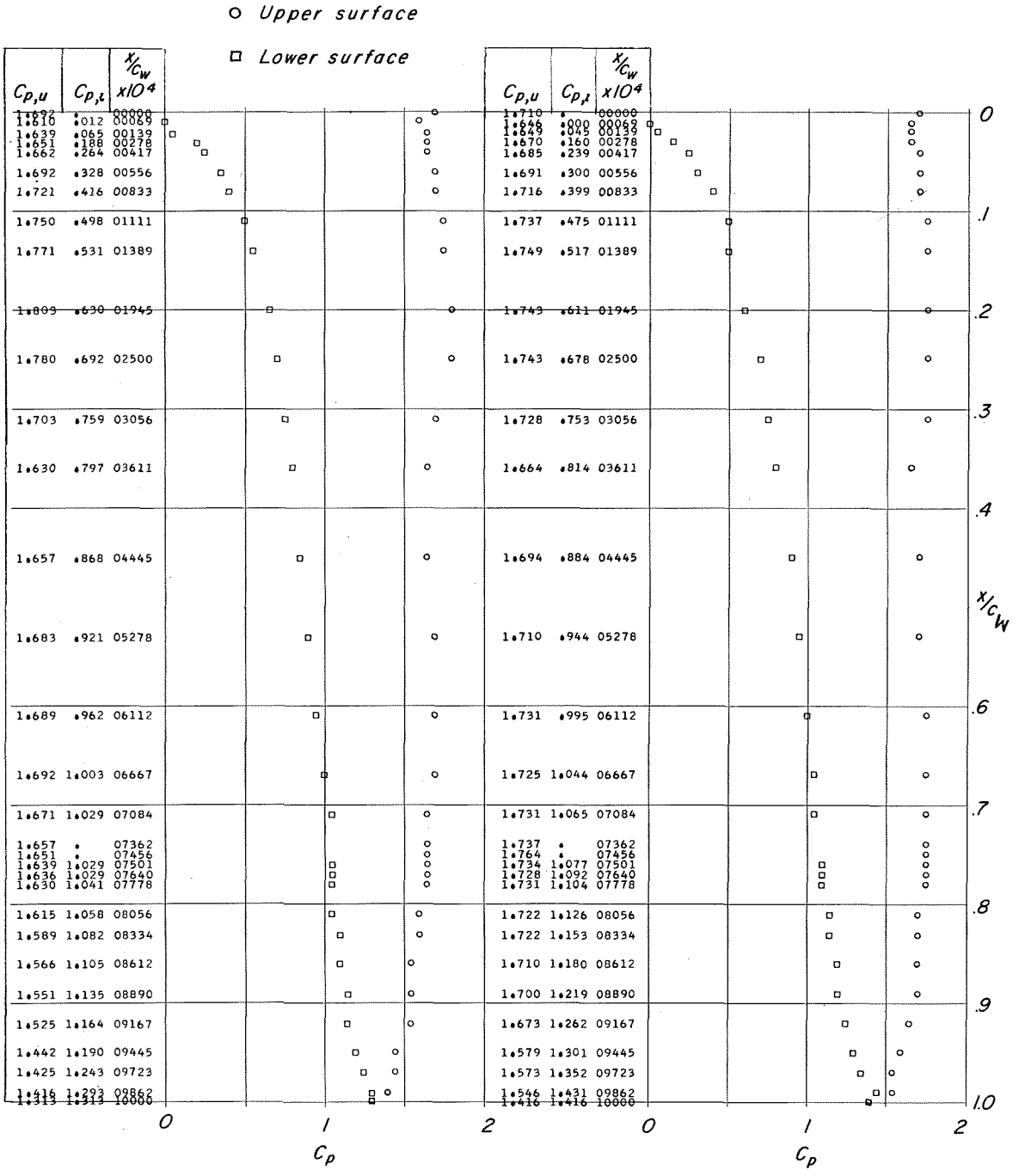


(f) $\alpha = 10^\circ$.

(g) $\alpha = 12^\circ$.

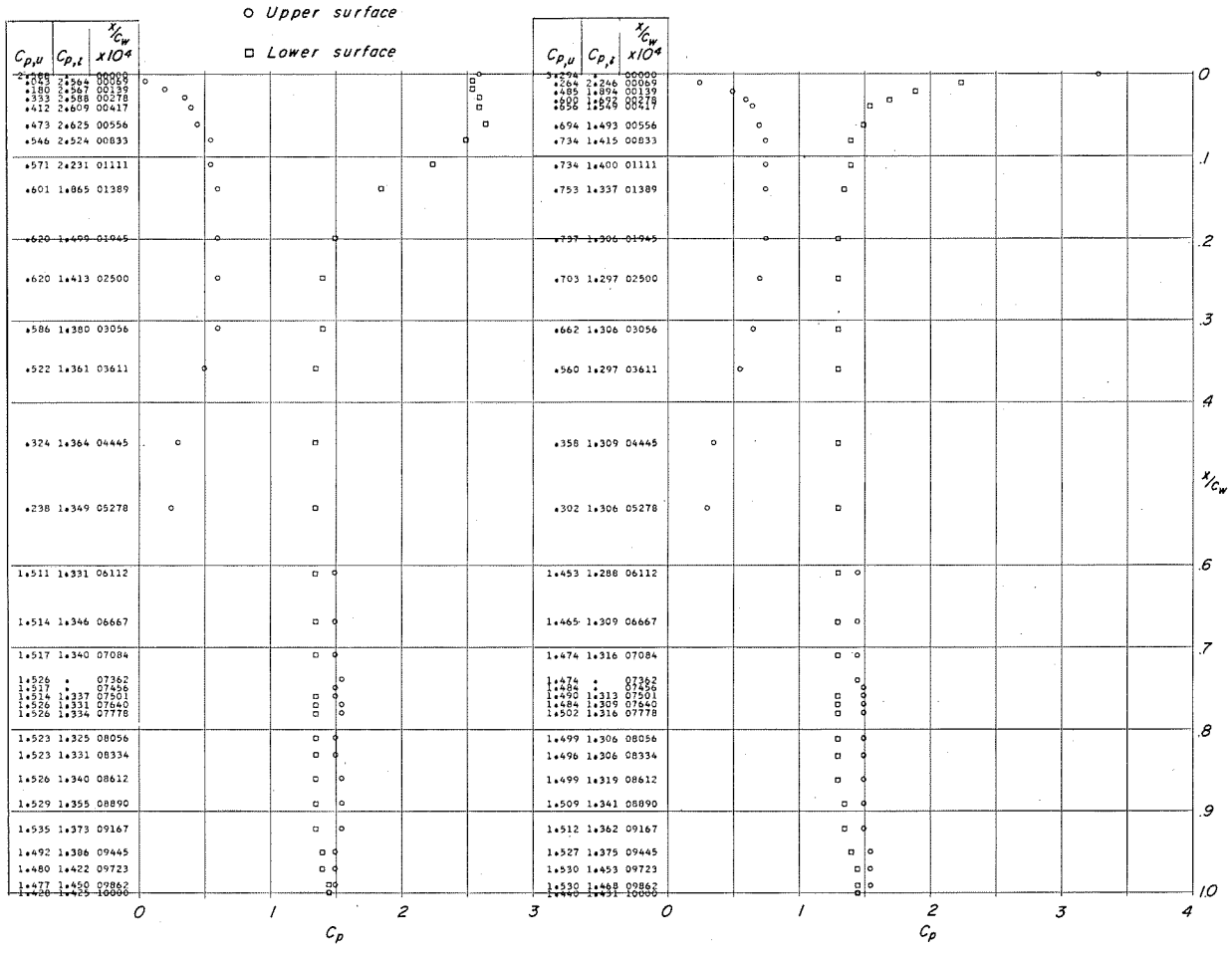
(h) $\alpha = 14^\circ$.

Figure 21.- Continued.



(i) $\alpha = 16^\circ$. (j) $\alpha = 18^\circ$.

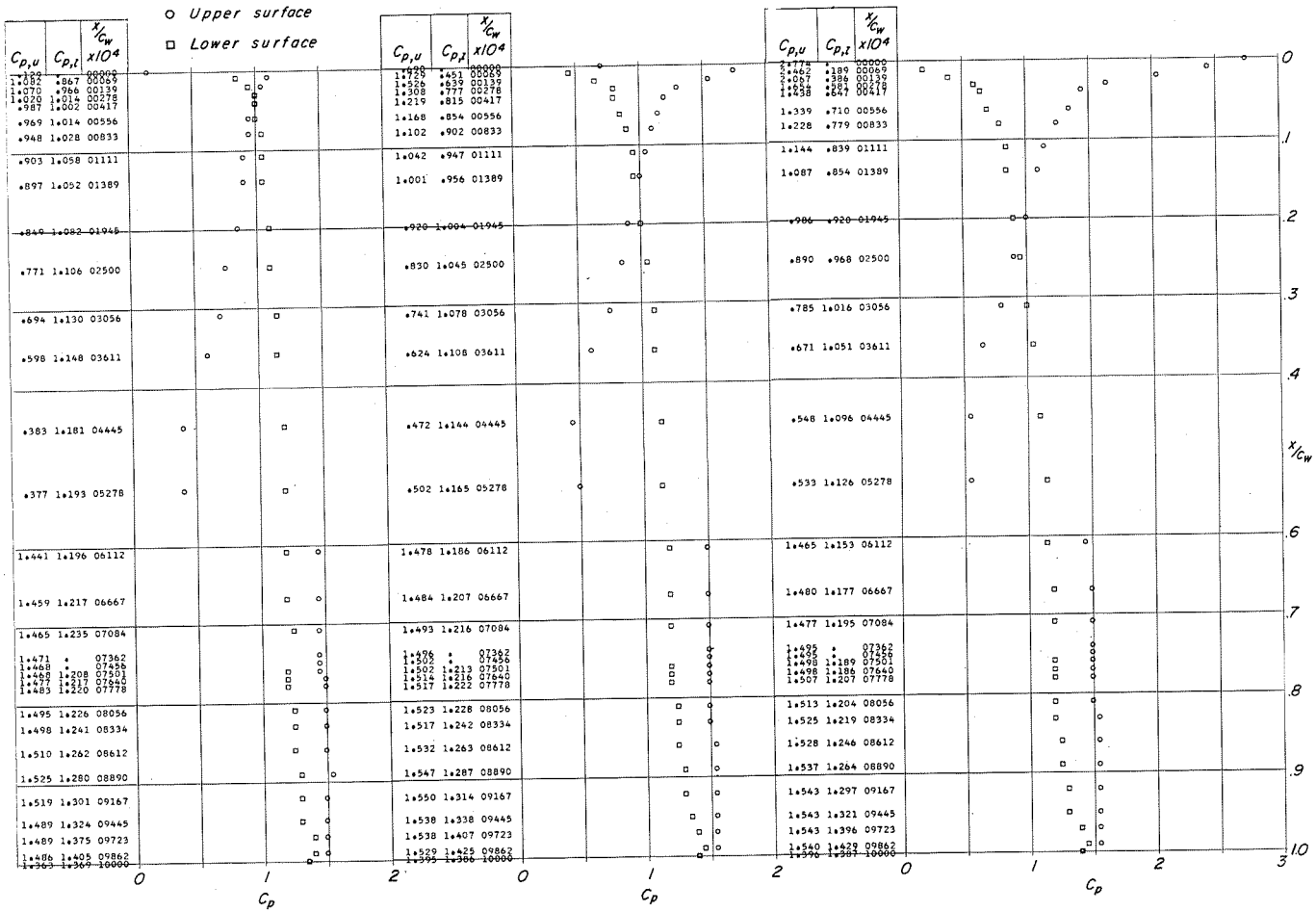
Figure 21.- Concluded.



(a) $\alpha = -4^\circ$.

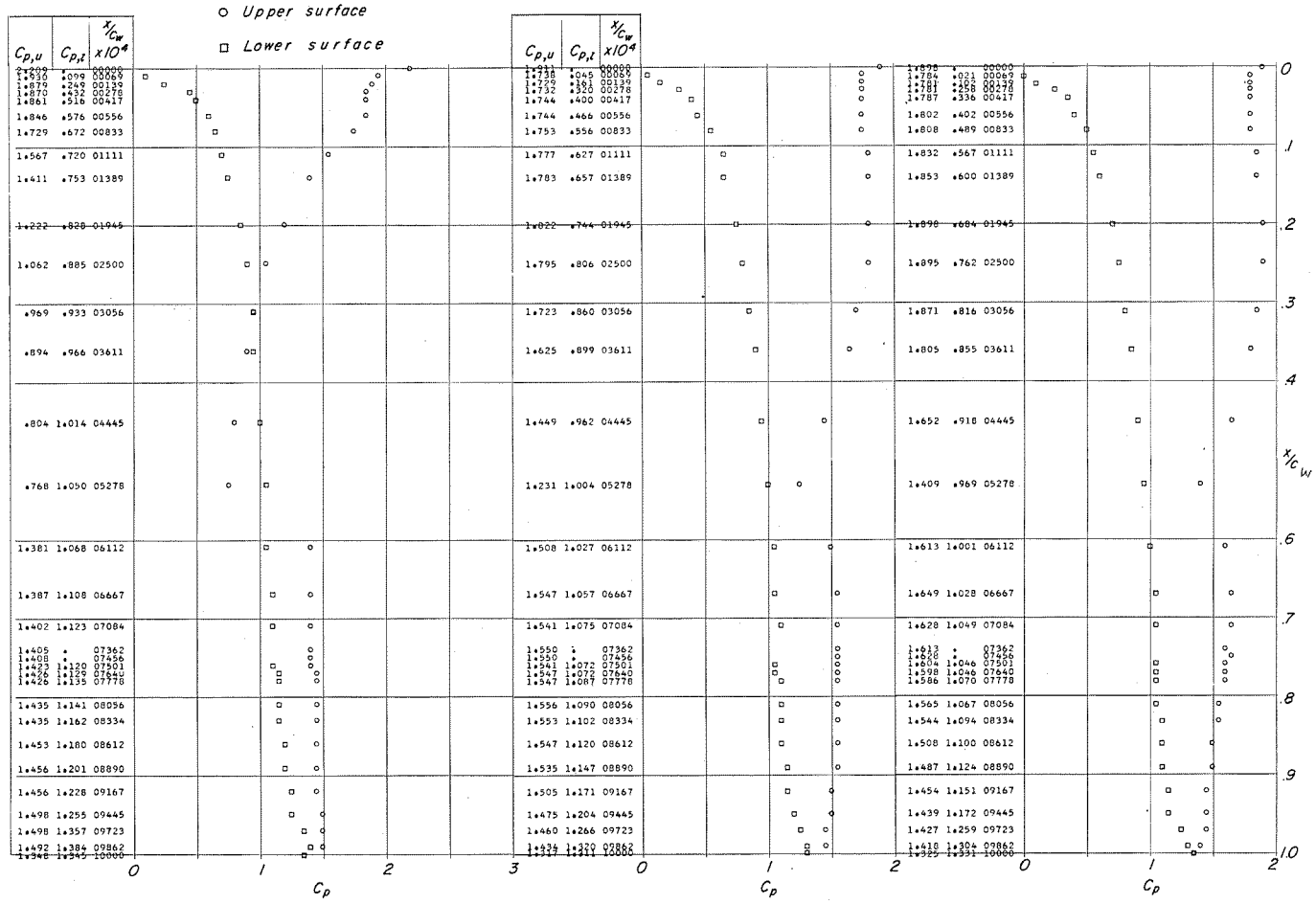
(b) $\alpha = 0^\circ$.

Figure 22.- Chordwise pressure distribution over model. $\delta_N = 0^\circ$; $\delta_f = 0^\circ$; full-span spoiler hinged at 0.50c; tabulated data of points plotted to left of plot.



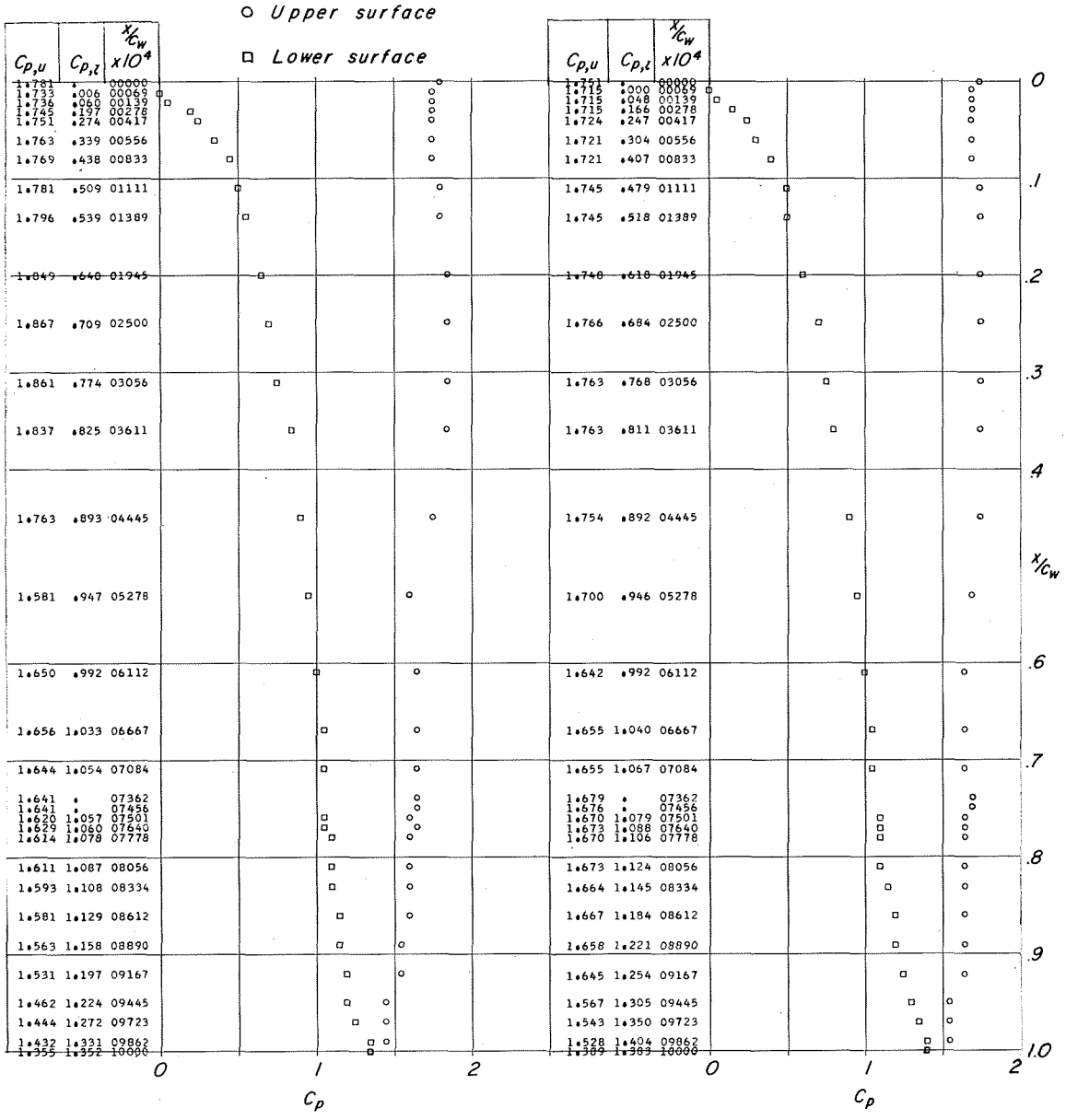
(c) $\alpha = 4^\circ$. (d) $\alpha = 6^\circ$. (e) $\alpha = 8^\circ$.

Figure 22.- Continued.



(f) $\alpha = 10^\circ$. (g) $\alpha = 12^\circ$. (h) $\alpha = 14^\circ$.

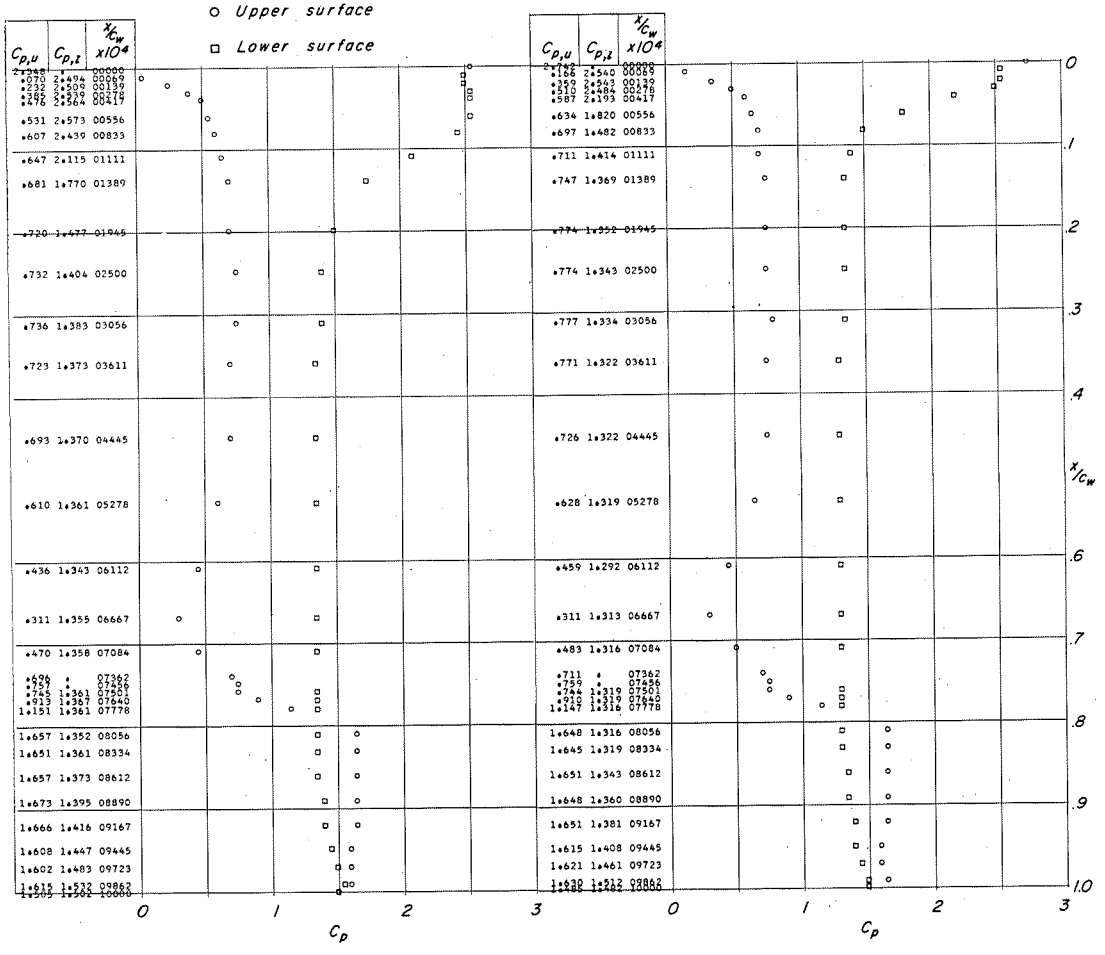
Figure 22.- Continued.



(i) $\alpha = 16^\circ$.

(j) $\alpha = 18^\circ$.

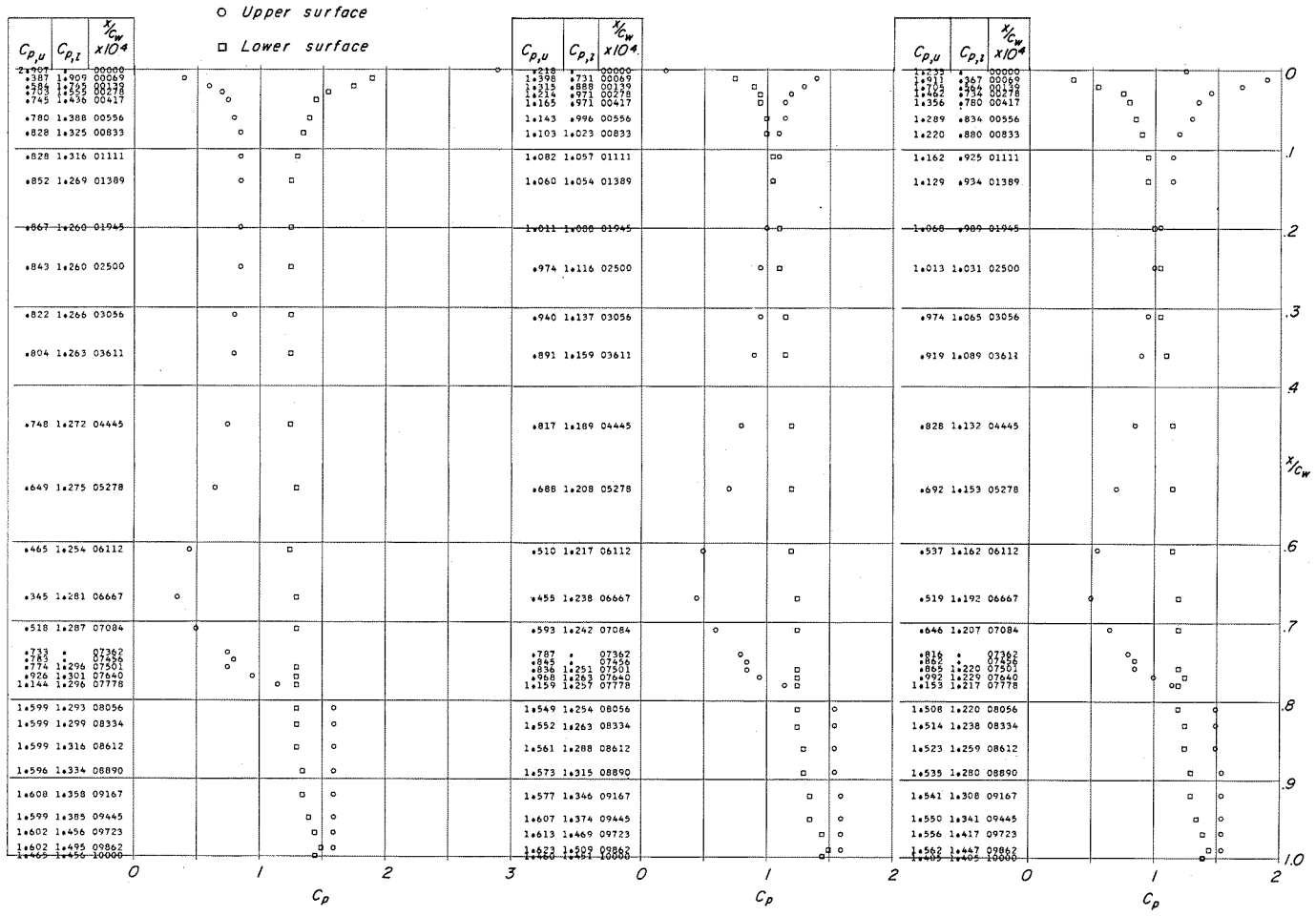
Figure 22.- Concluded.



(a) $\alpha = -4^\circ$.

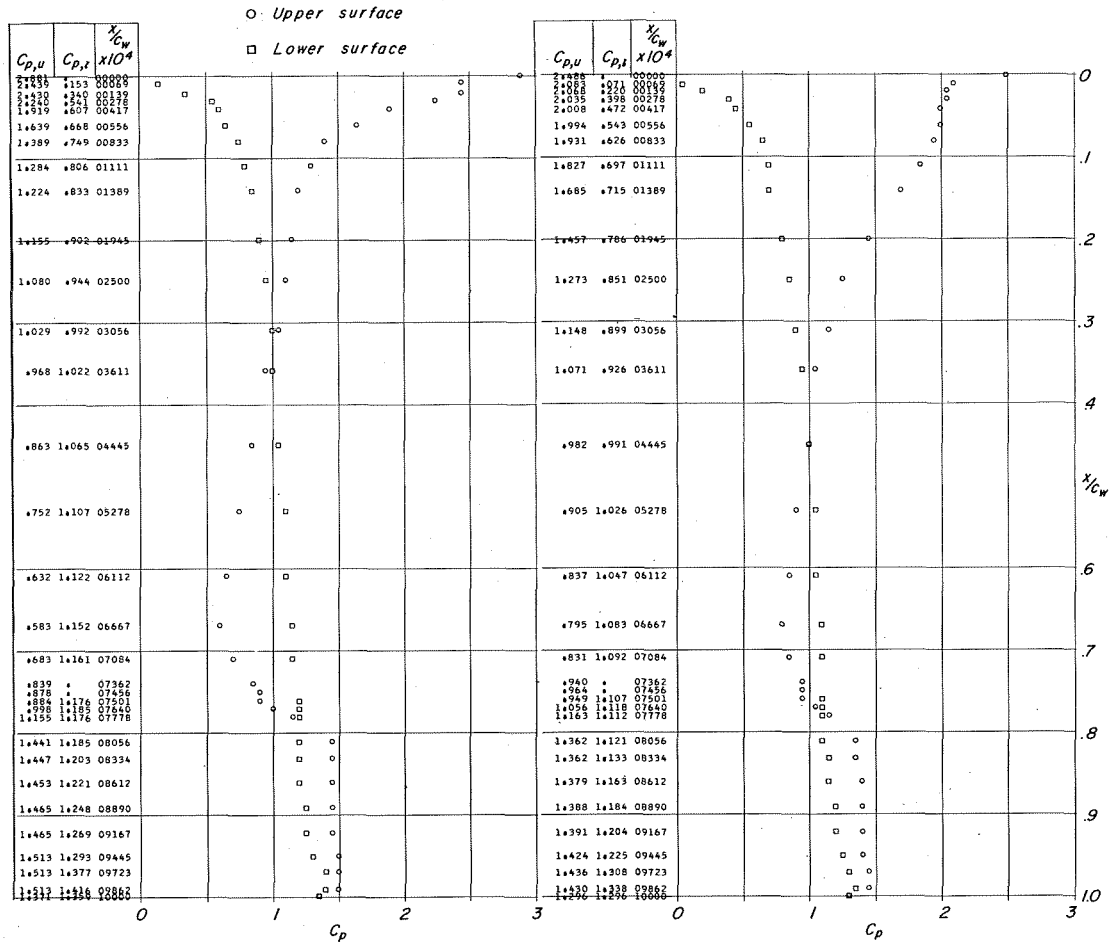
(b) $\alpha = -2^\circ$.

Figure 23.- Chordwise pressure distribution over model. $\delta_N = 0^\circ$; $\delta_f = 0^\circ$; full-span spoiler hinged at 0.70c; tabulated data of points plotted to left of plot.



(c) $\alpha = 0°$. (d) $\alpha = 4°$. (e) $\alpha = 6°$.

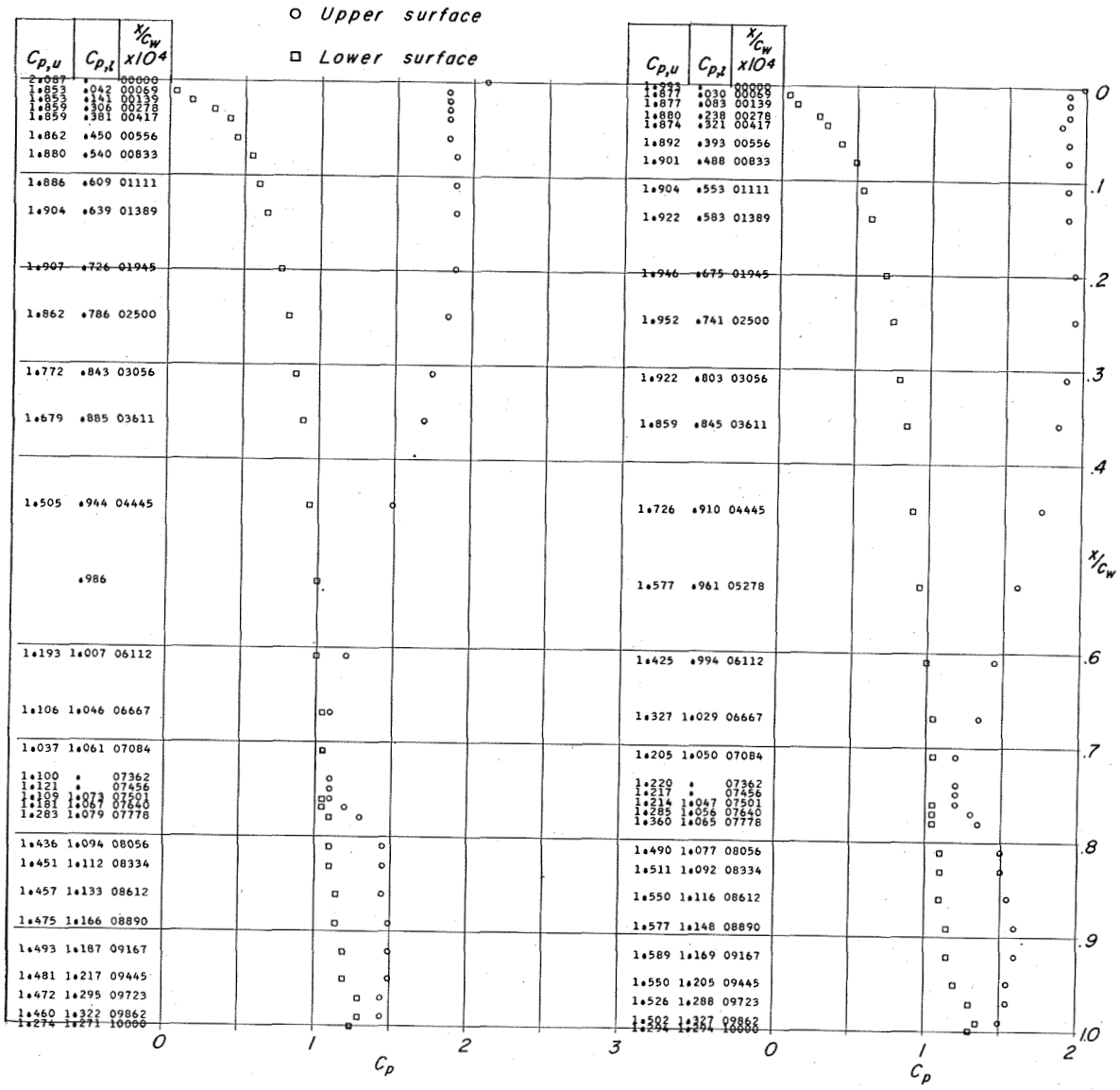
Figure 23.- Continued.



(f) $\alpha = 8^\circ$.

(g) $\alpha = 10^\circ$.

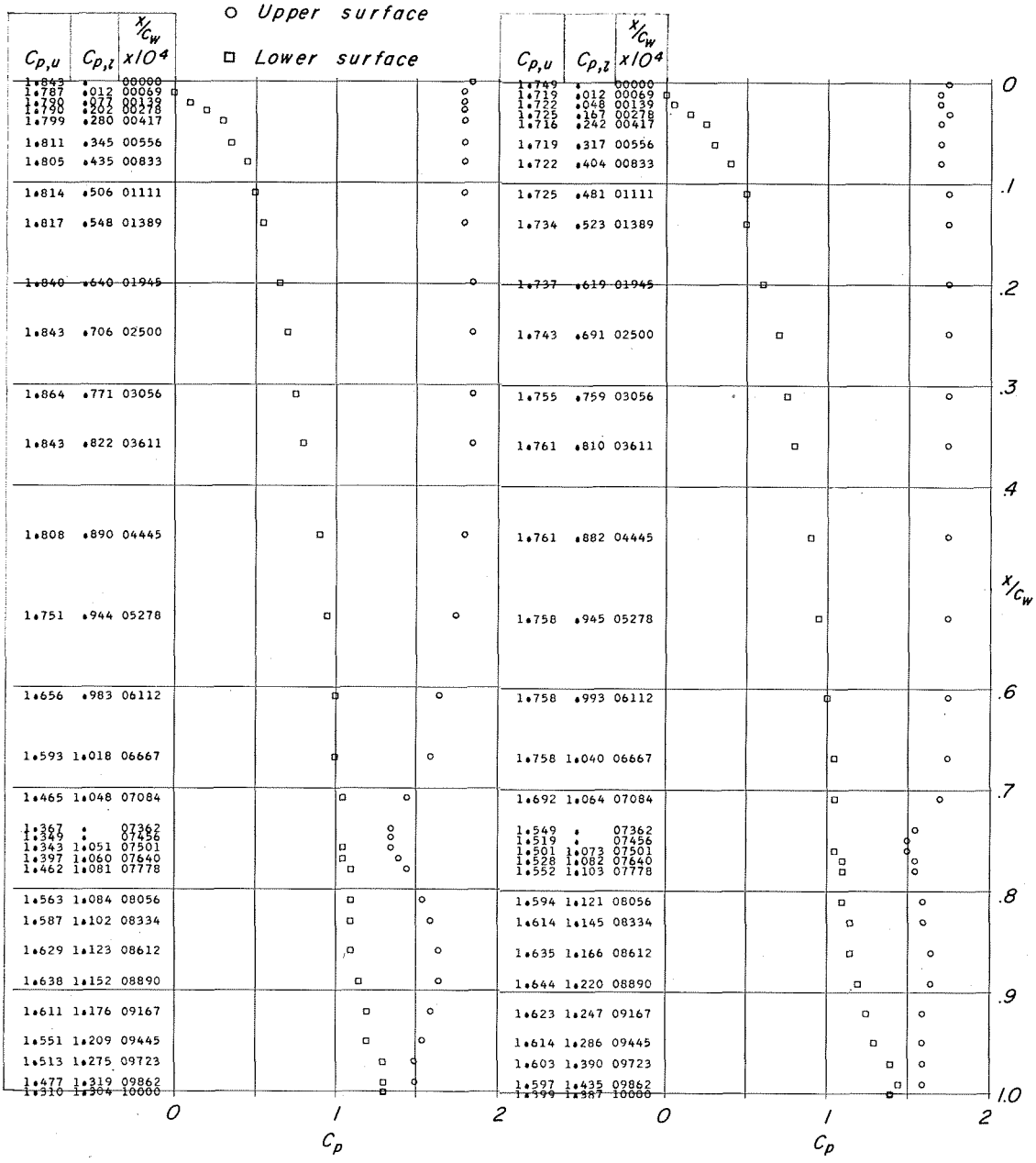
Figure 23.- Continued.



(h) $\alpha = 12^\circ$.

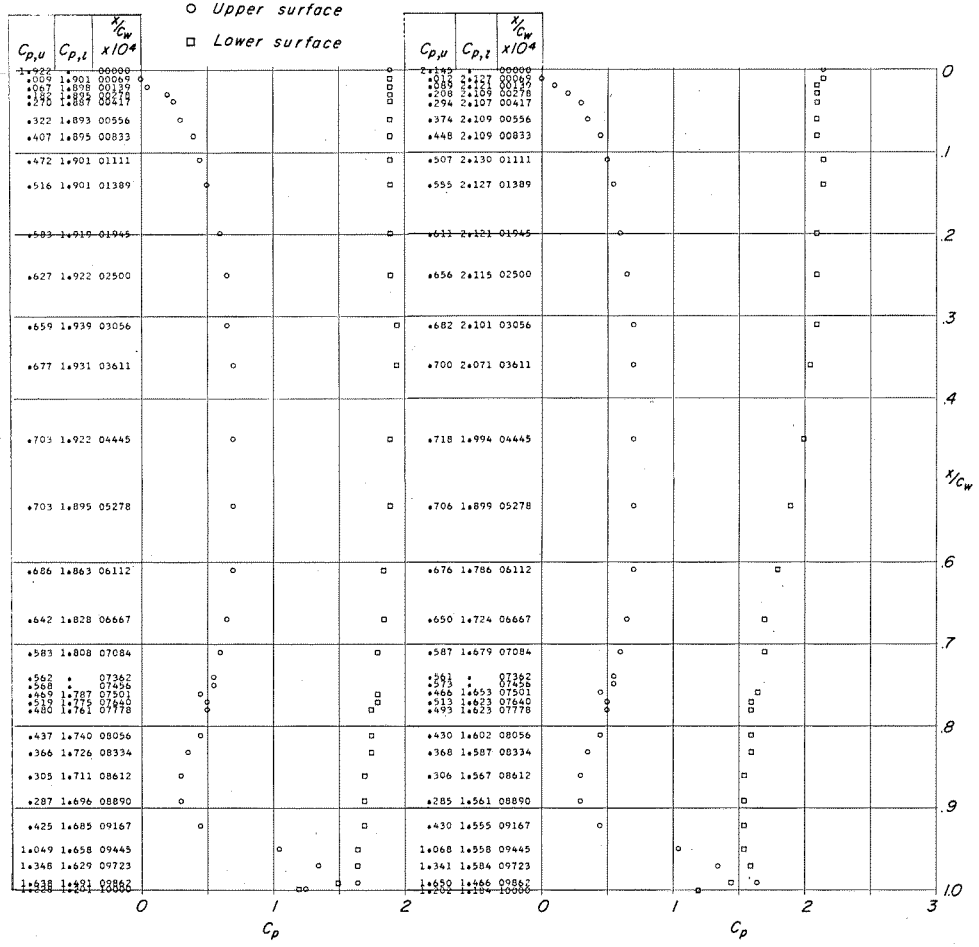
(i) $\alpha = 14^\circ$.

Figure 23.- Continued.



(j) $\alpha = 16^\circ$. (k) $\alpha = 18^\circ$.

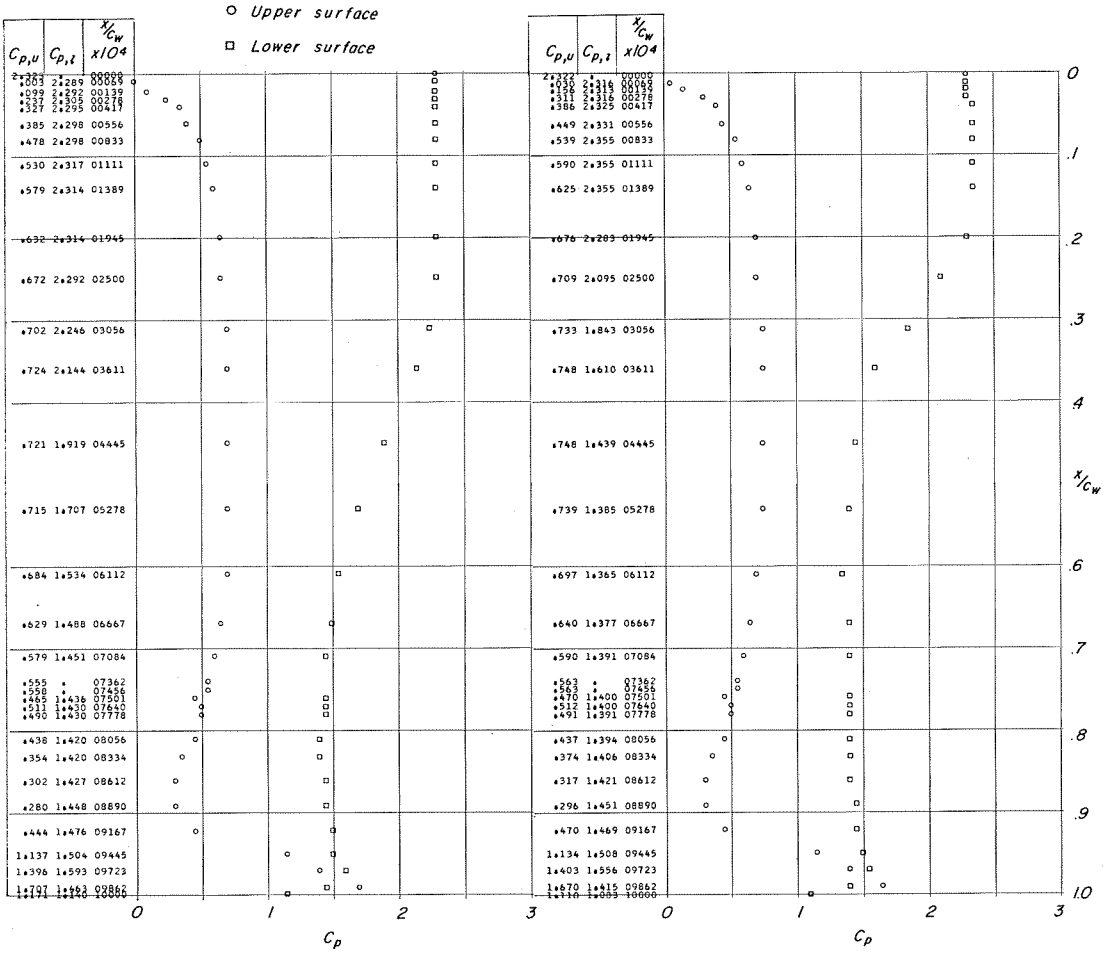
Figure 23.- Concluded.



(a) $\alpha = -12^\circ$.

(b) $\alpha = -10^\circ$.

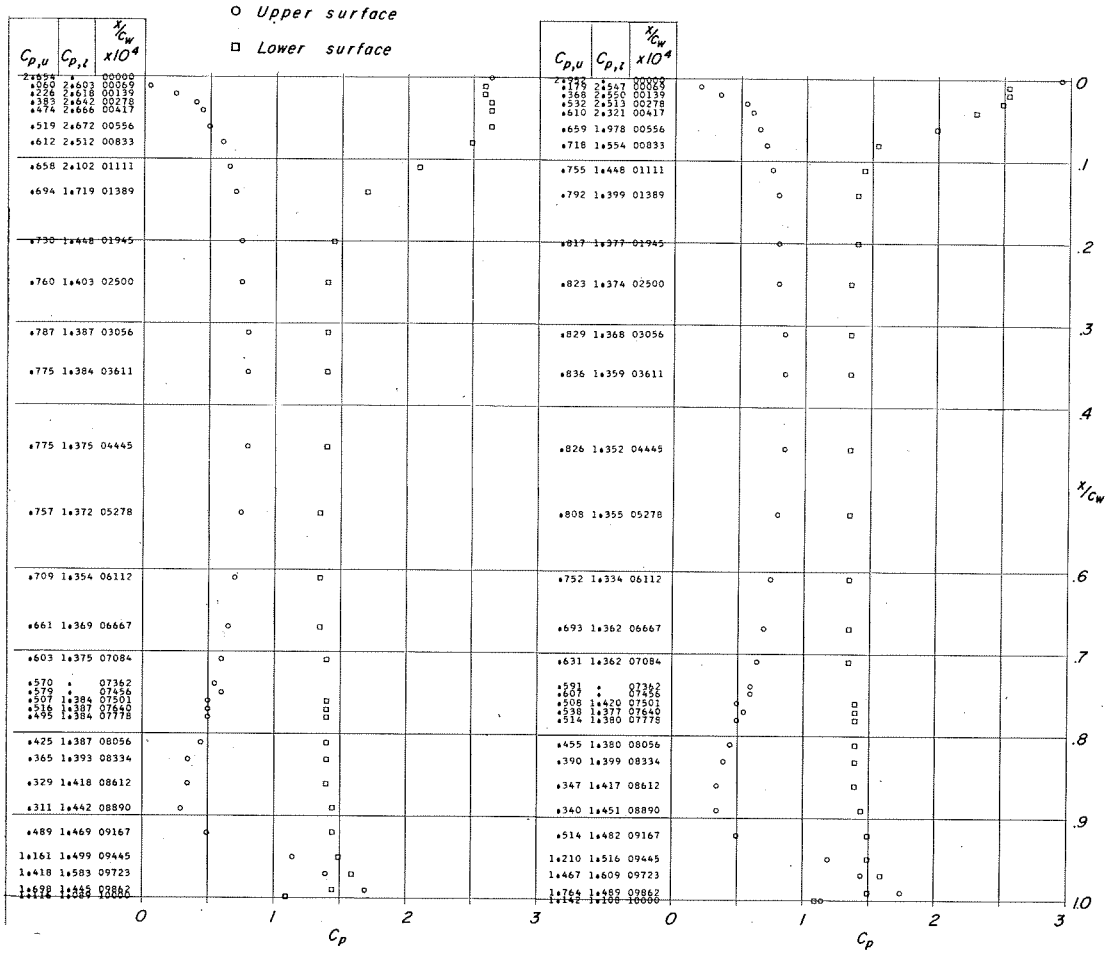
Figure 24.- Chordwise pressure distribution over model. $\delta_N = 0^\circ$; $\delta_f = 0^\circ$; full-span spoiler hinged at 0.90c; tabulated data of points plotted to left of plot.



(c) $\alpha = -8^\circ$.

(d) $\alpha = -6^\circ$.

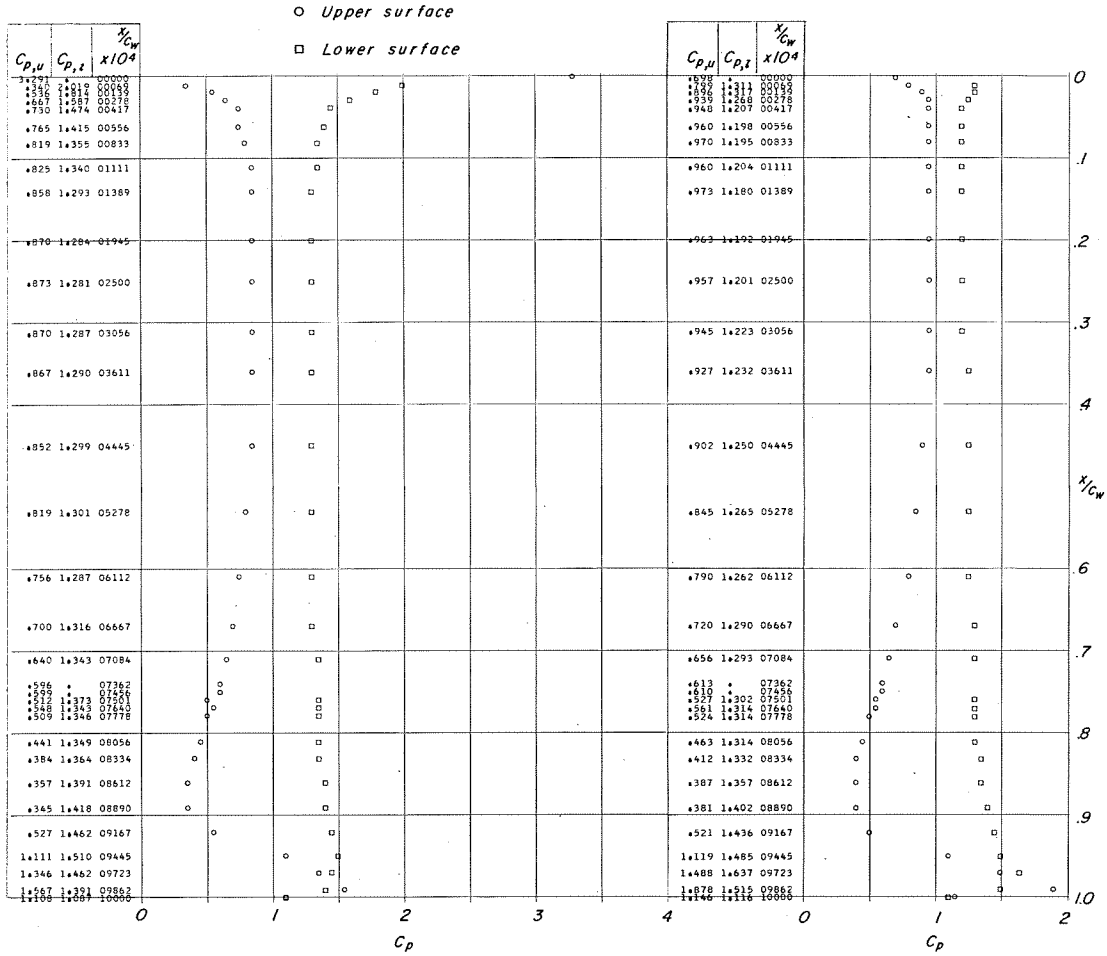
Figure 24.- Continued.



(e) $\alpha = -4^\circ$.

(f) $\alpha = -2^\circ$.

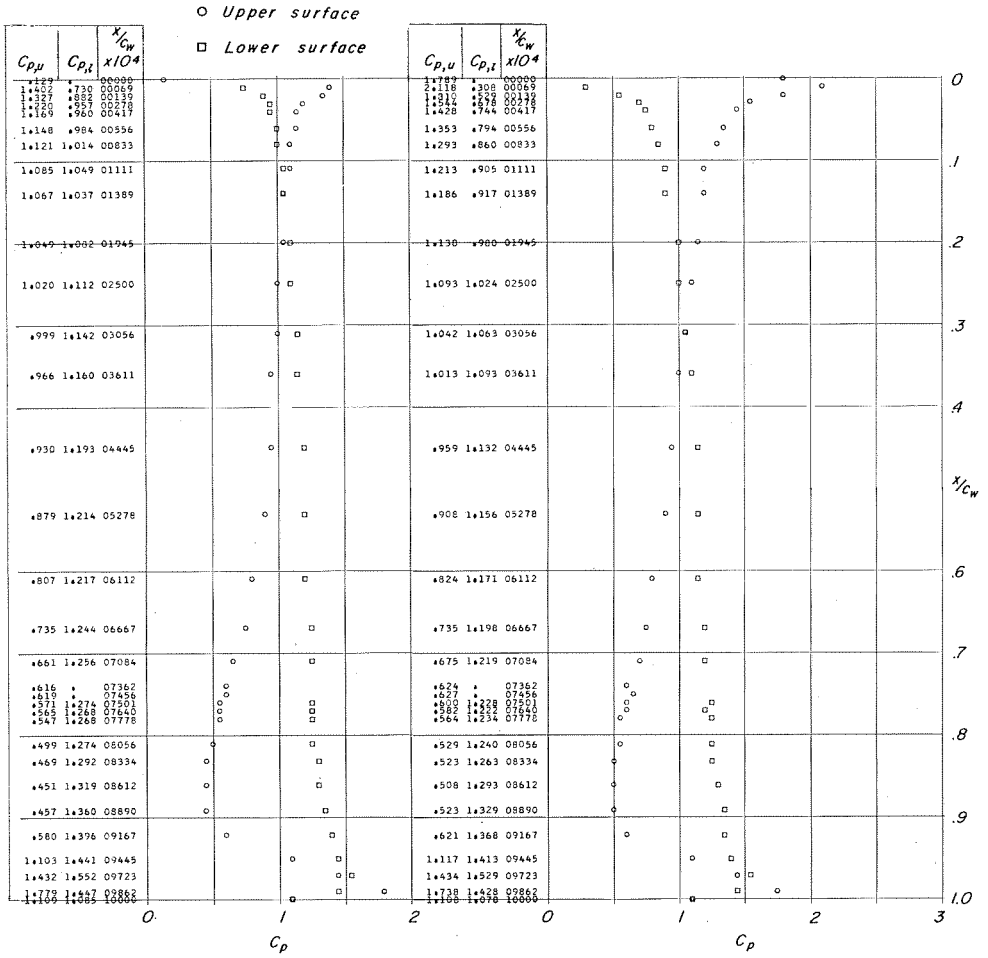
Figure 24.- Continued.



(g) $\alpha = 0^\circ$.

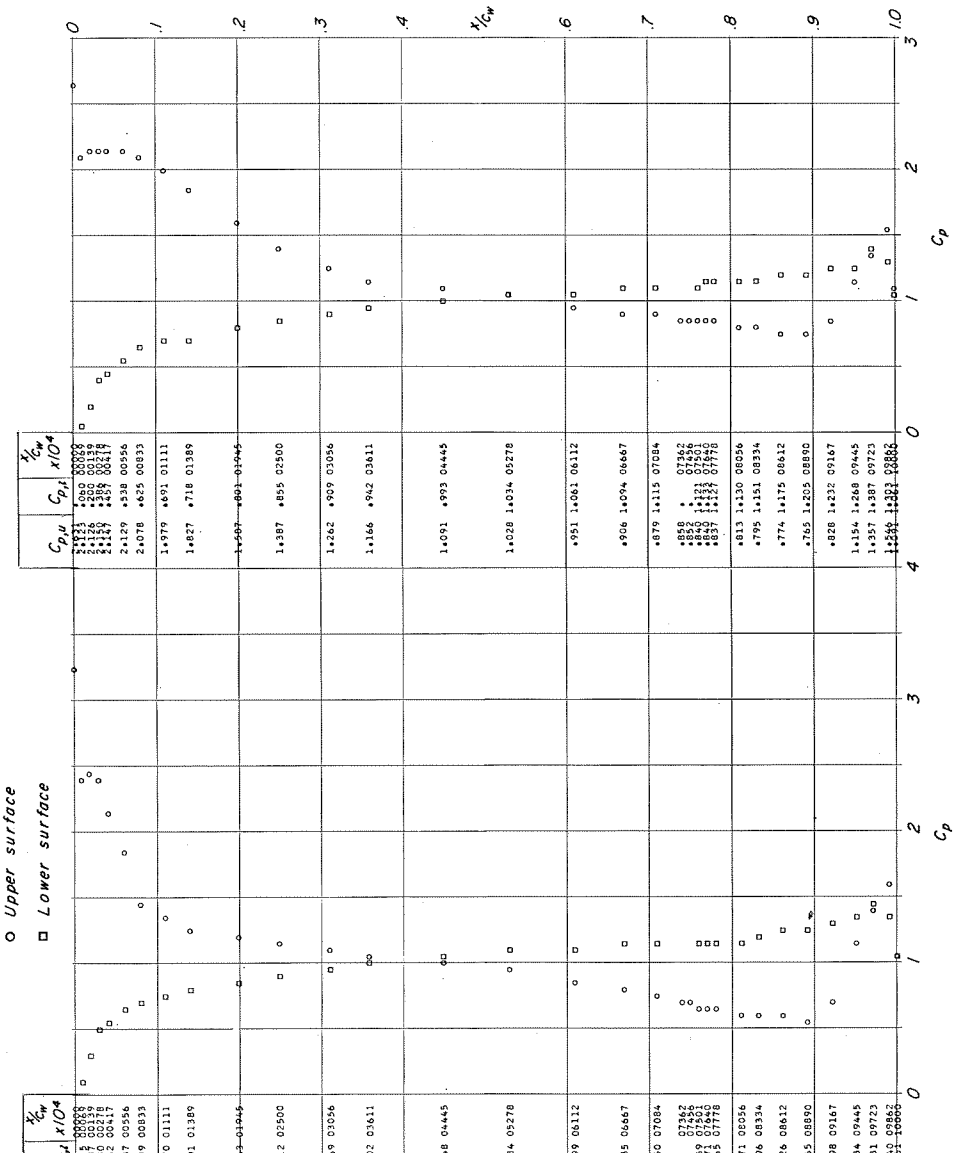
(h) $\alpha = 2^\circ$.

Figure 24.- Continued.



(i) $\alpha = 4^\circ$. (j) $\alpha = 6^\circ$.

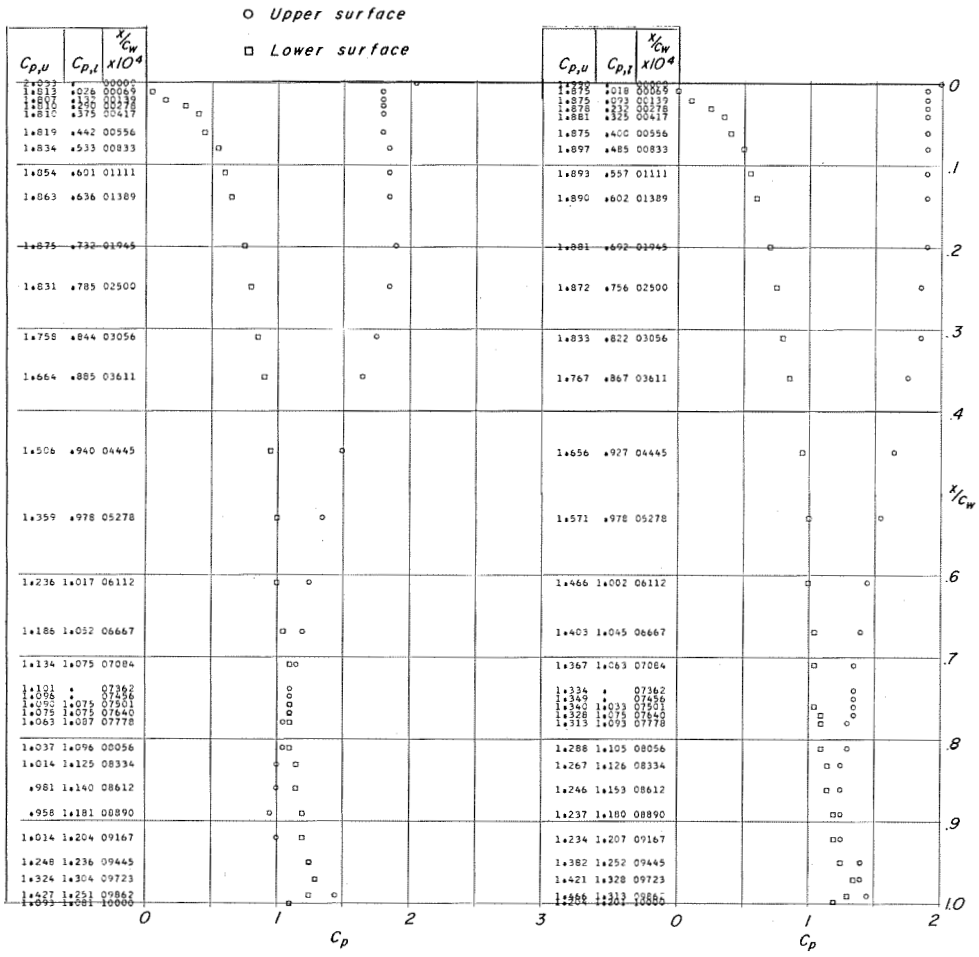
Figure 24.- Continued.



(k) $\alpha = 8^\circ$.

(l) $\alpha = 10^\circ$.

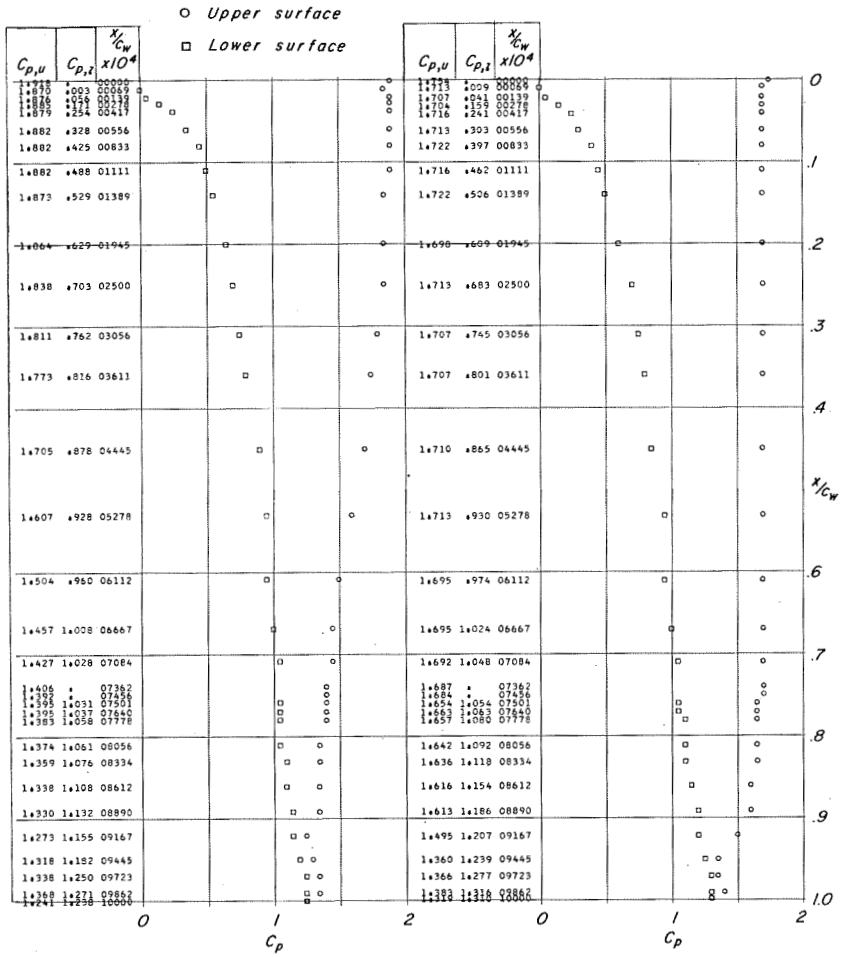
Figure 24.- Continued.



(m) $\alpha = 12^\circ$.

(n) $\alpha = 14^\circ$.

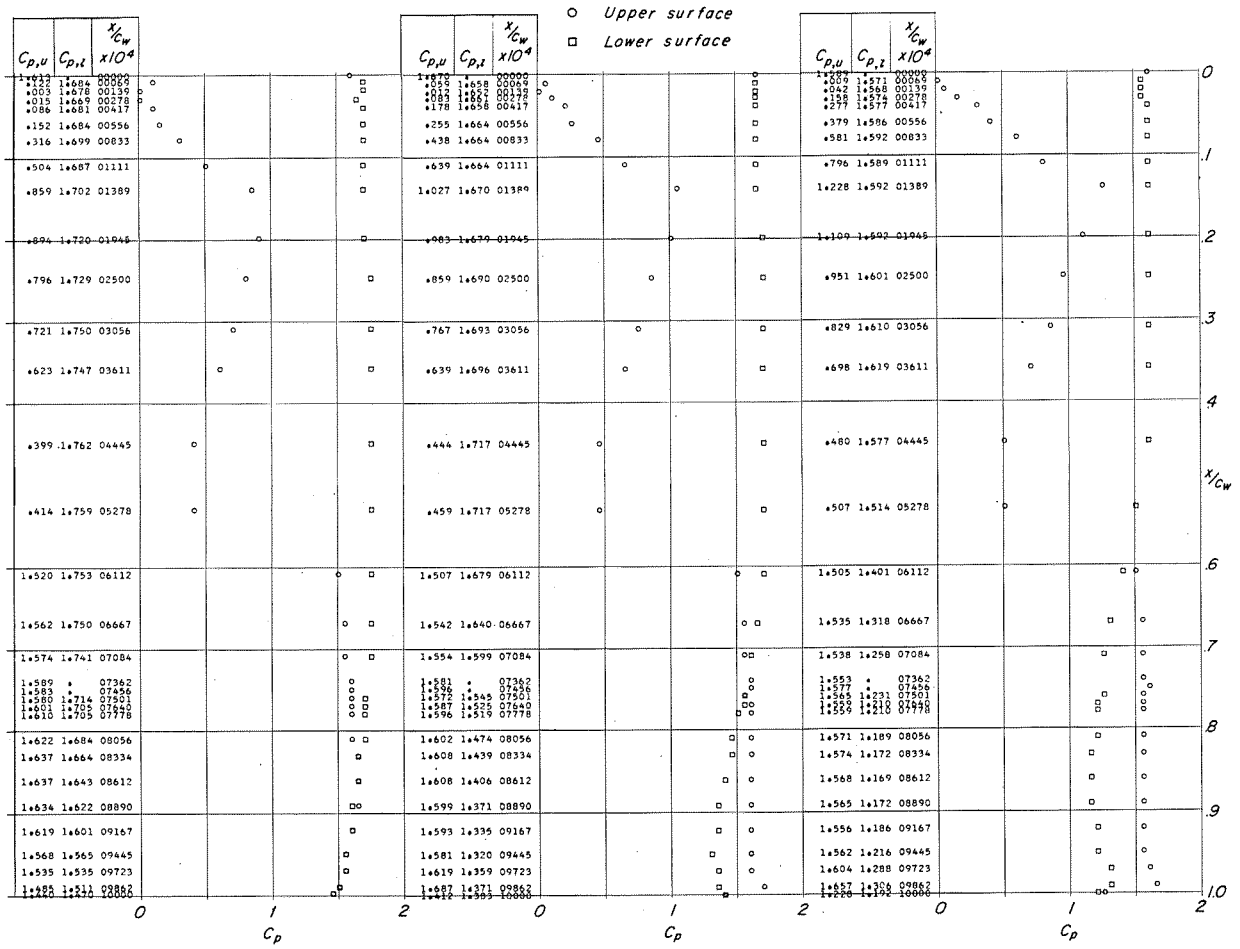
Figure 24.- Continued.



(o) $\alpha = 16^\circ$.

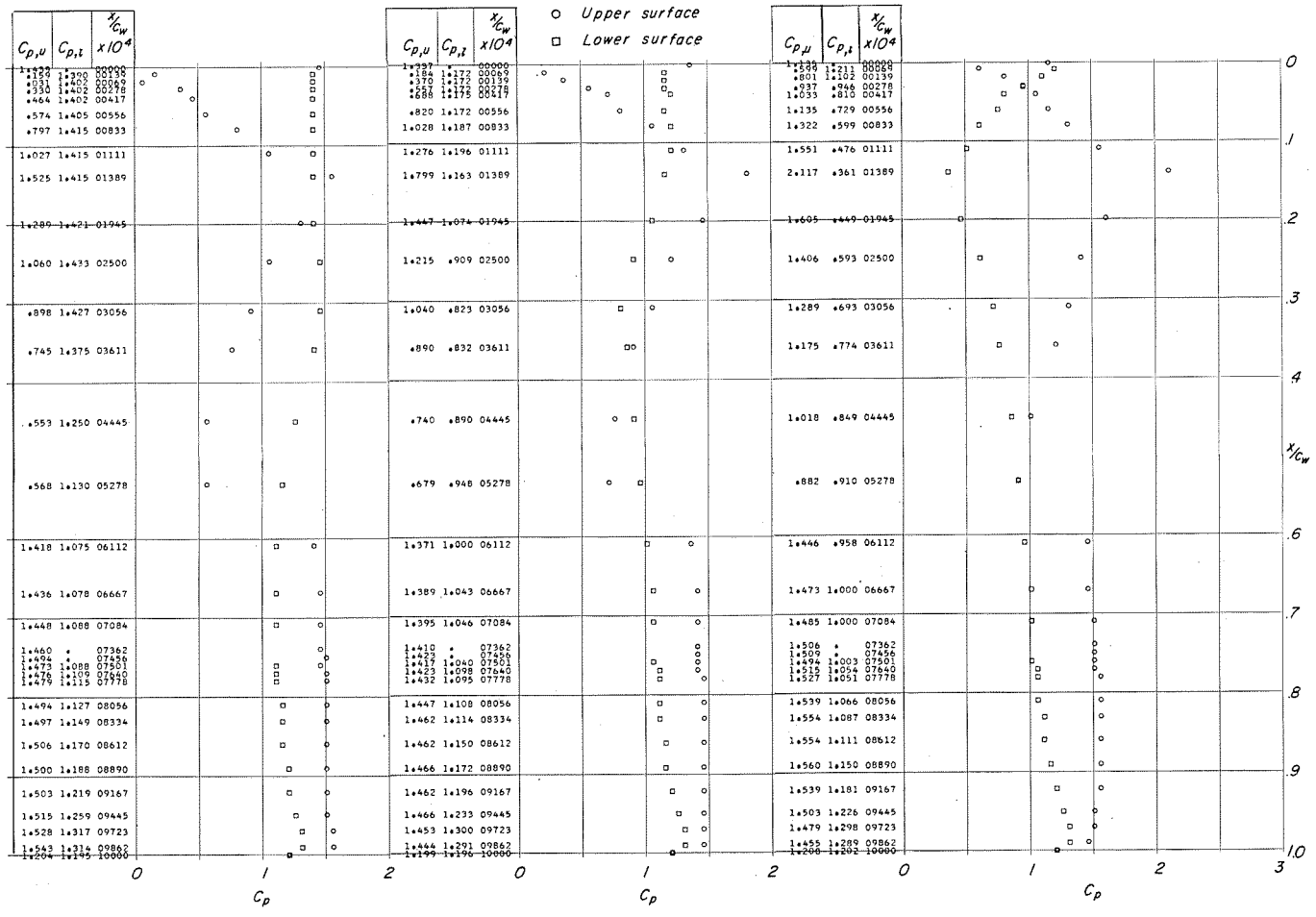
(p) $\alpha = 18^\circ$.

Figure 24.- Concluded.



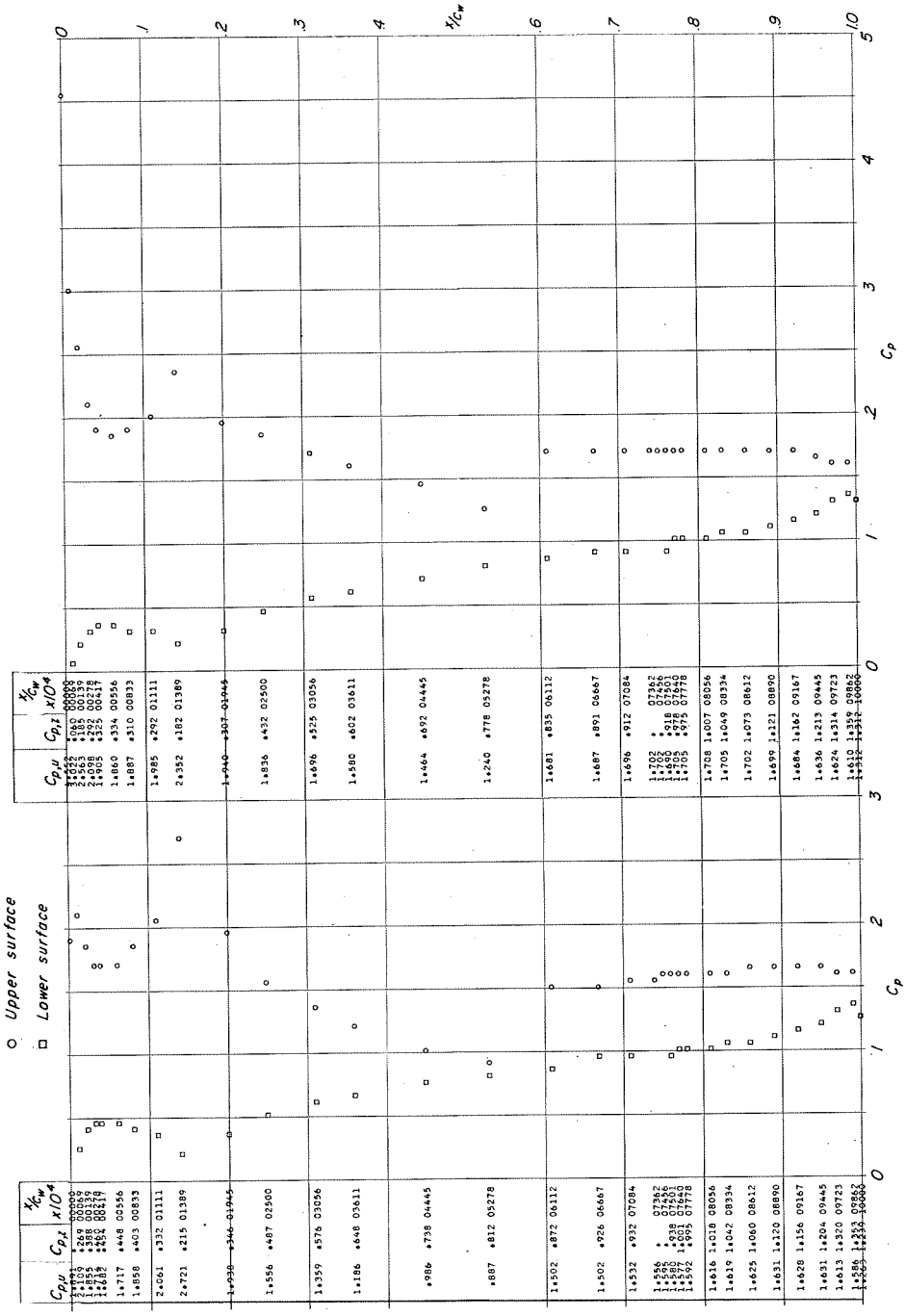
(a) $\alpha = -8^\circ$. (b) $\alpha = -4^\circ$. (c) $\alpha = 0^\circ$.

Figure 25.- Chordwise pressure distribution over model. $\delta_N = 30^\circ$; $\delta_f = 0^\circ$; half-span outboard spoiler hinged at 0.50c; tabulated data of points plotted to left of plot.



(d) $\alpha = 4^\circ$. (e) $\alpha = 8^\circ$. (f) $\alpha = 12^\circ$.

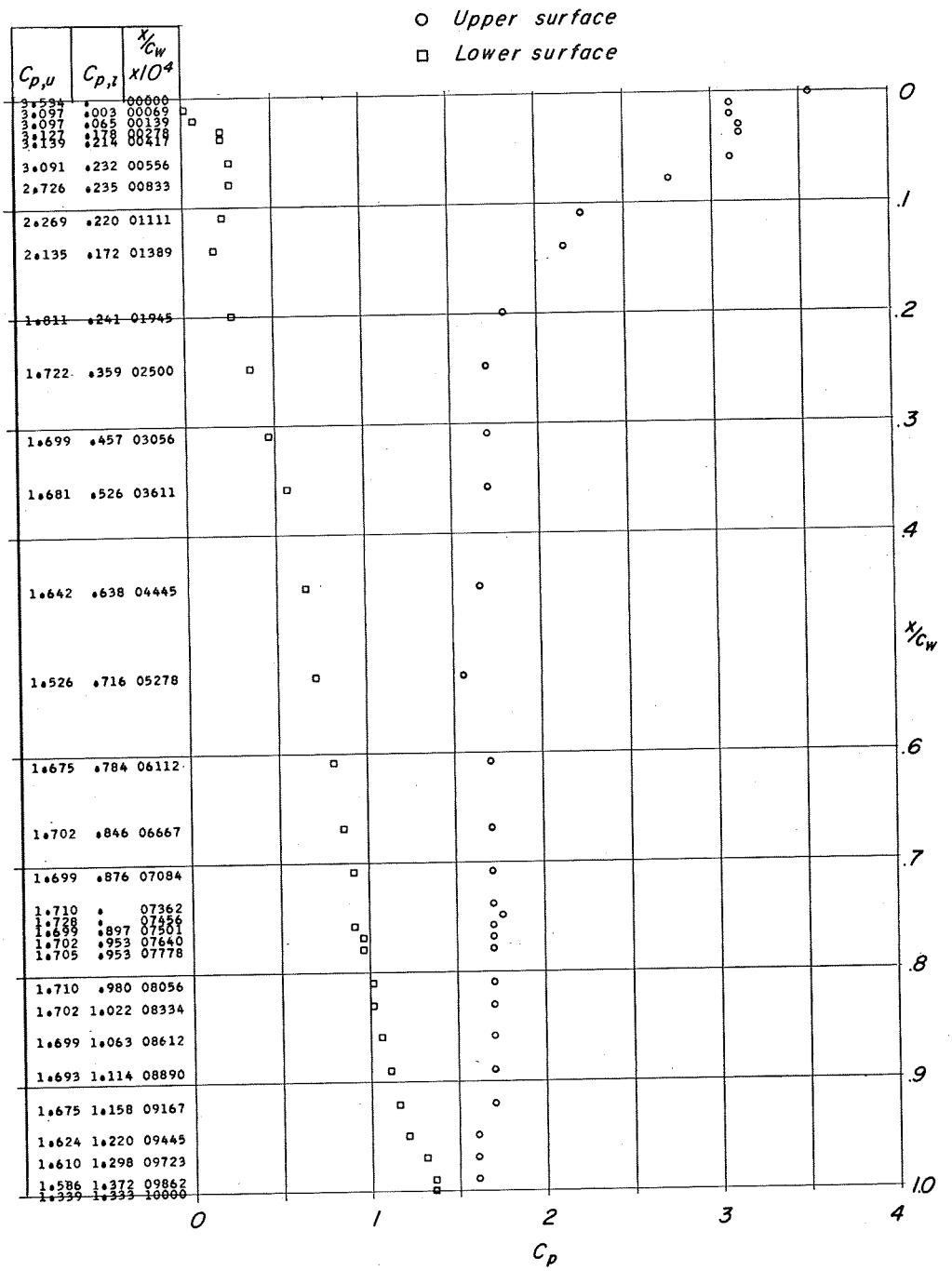
Figure 25.- Continued.



(g) $\alpha = 16°$.

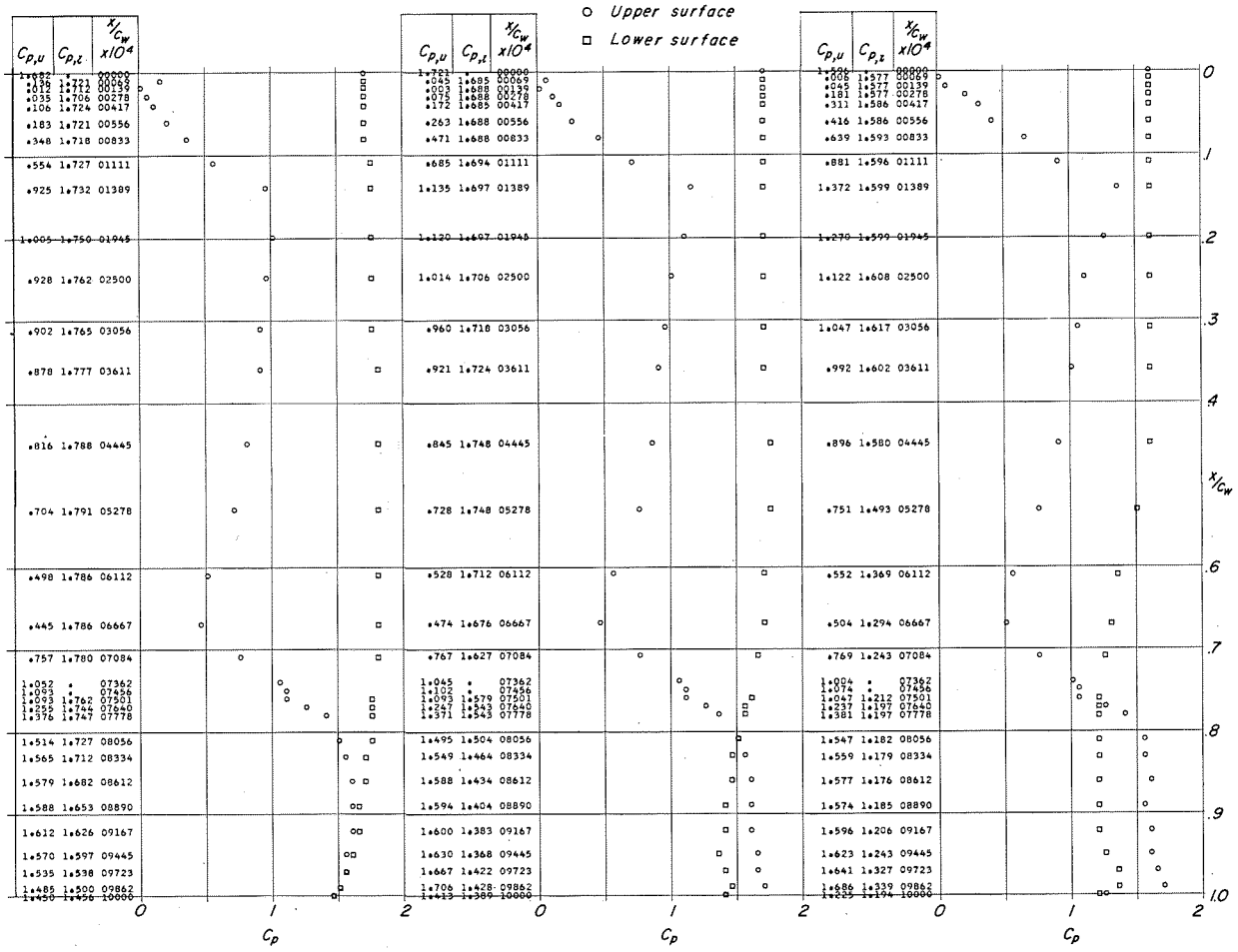
(h) $\alpha = 20°$.

Figure 25.- Continued.



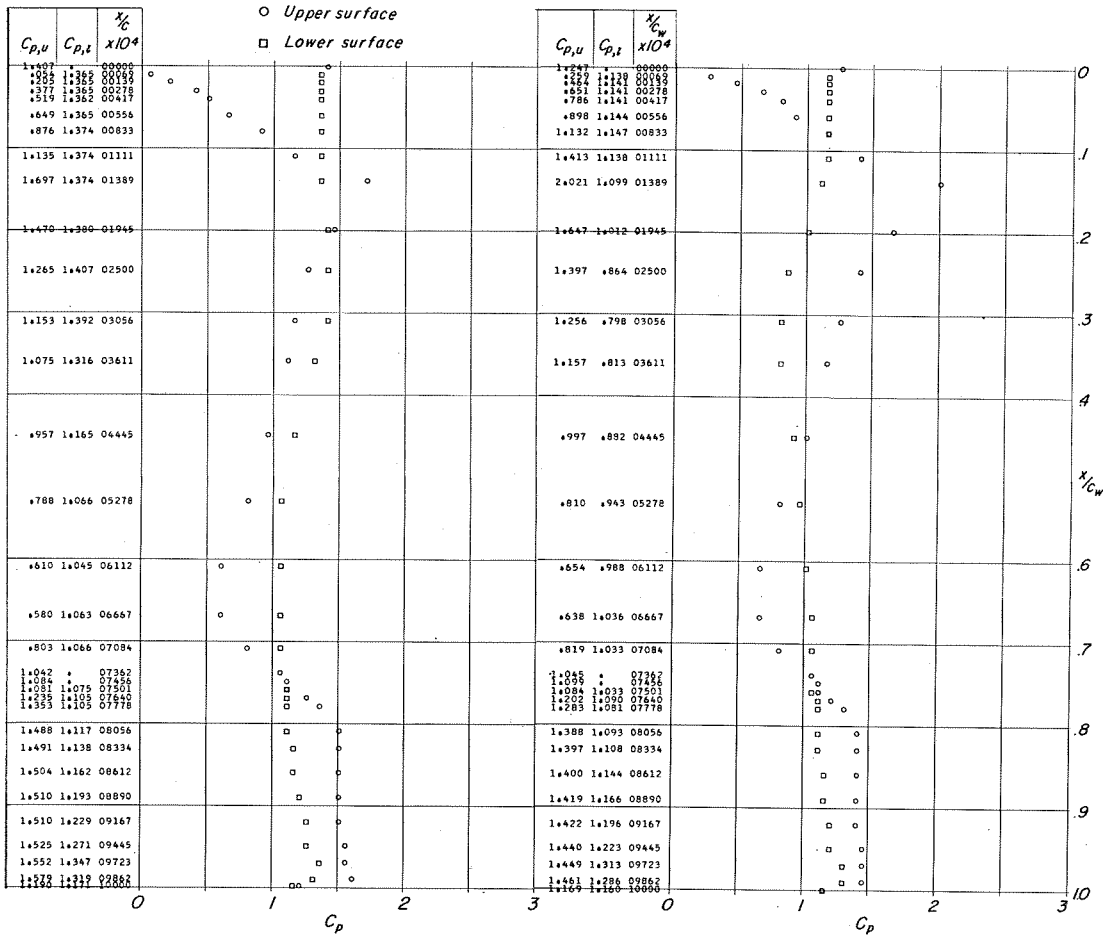
(i) $\alpha = 24^\circ$.

Figure 25.- Concluded.



(a) $\alpha = -8^\circ$. (b) $\alpha = -4^\circ$. (c) $\alpha = 0^\circ$.

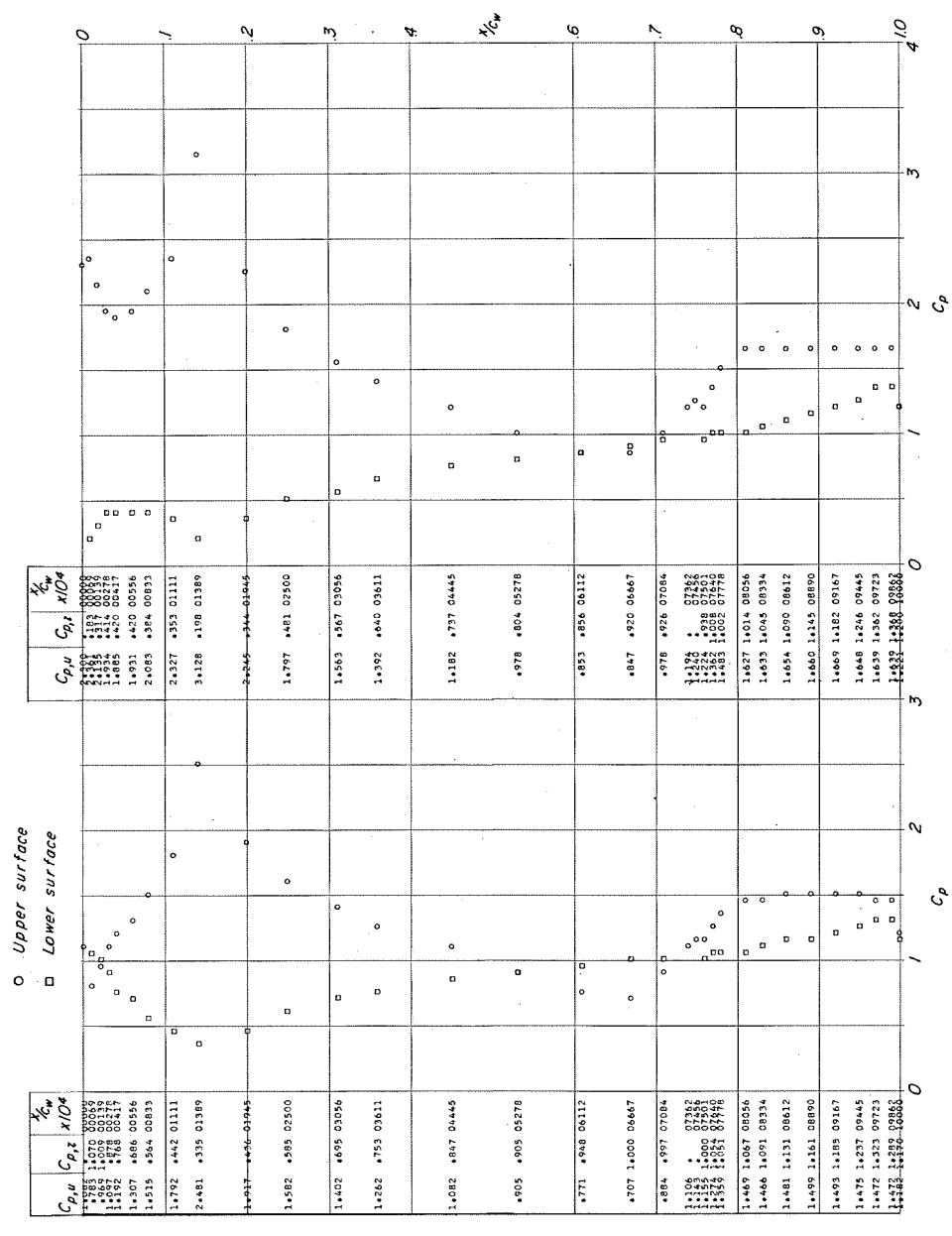
Figure 26.- Chordwise pressure distribution over model. $\delta_N = 30^\circ$; $\delta_f = 0^\circ$; half-span outboard spoiler hinged at 0.70c; tabulated data of points plotted to left of plot.



(d) $\alpha = 4^\circ$.

(e) $\alpha = 8^\circ$.

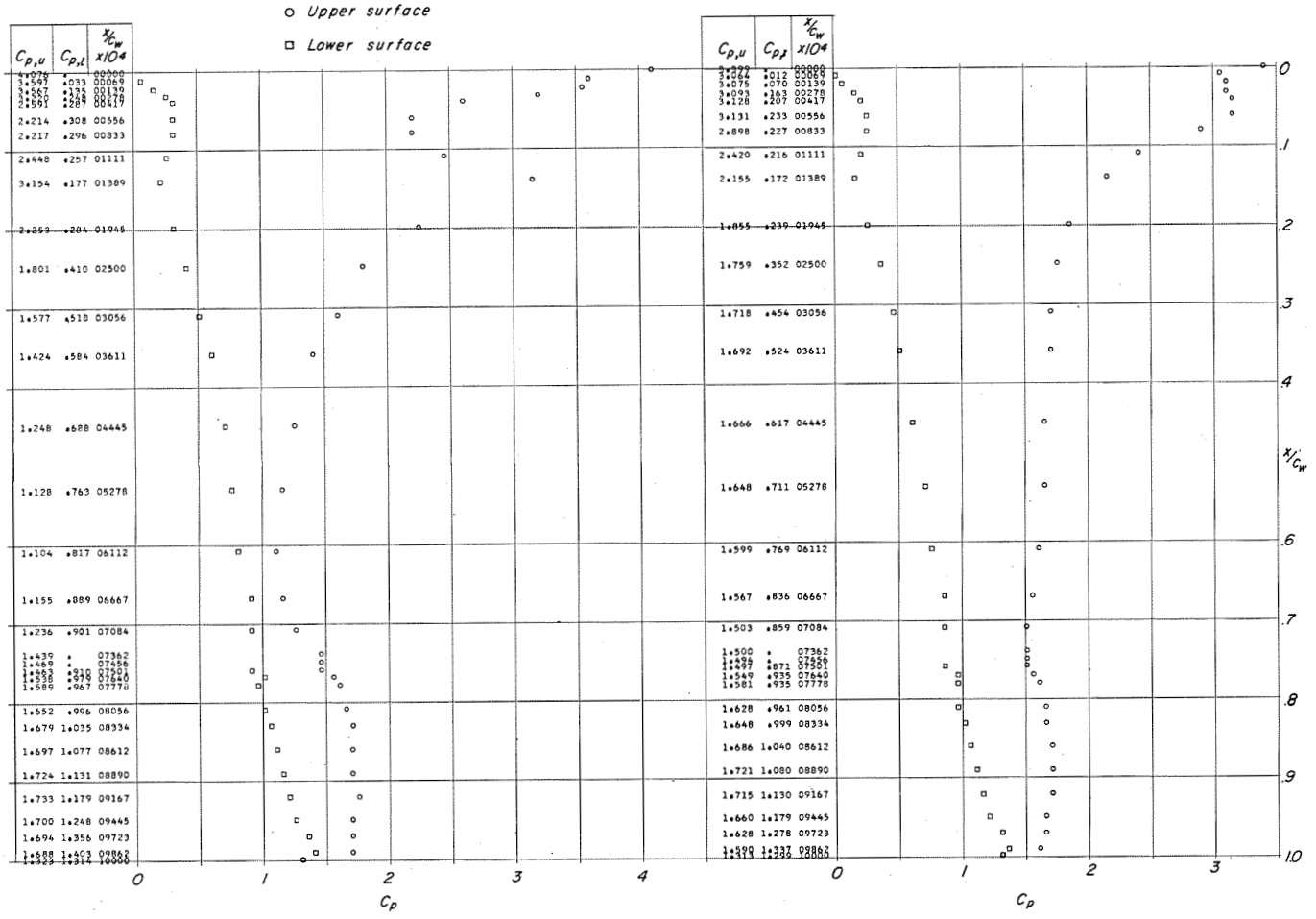
Figure 26.- Continued.



(f) $\alpha = 12^\circ$.

(g) $\alpha = 16^\circ$.

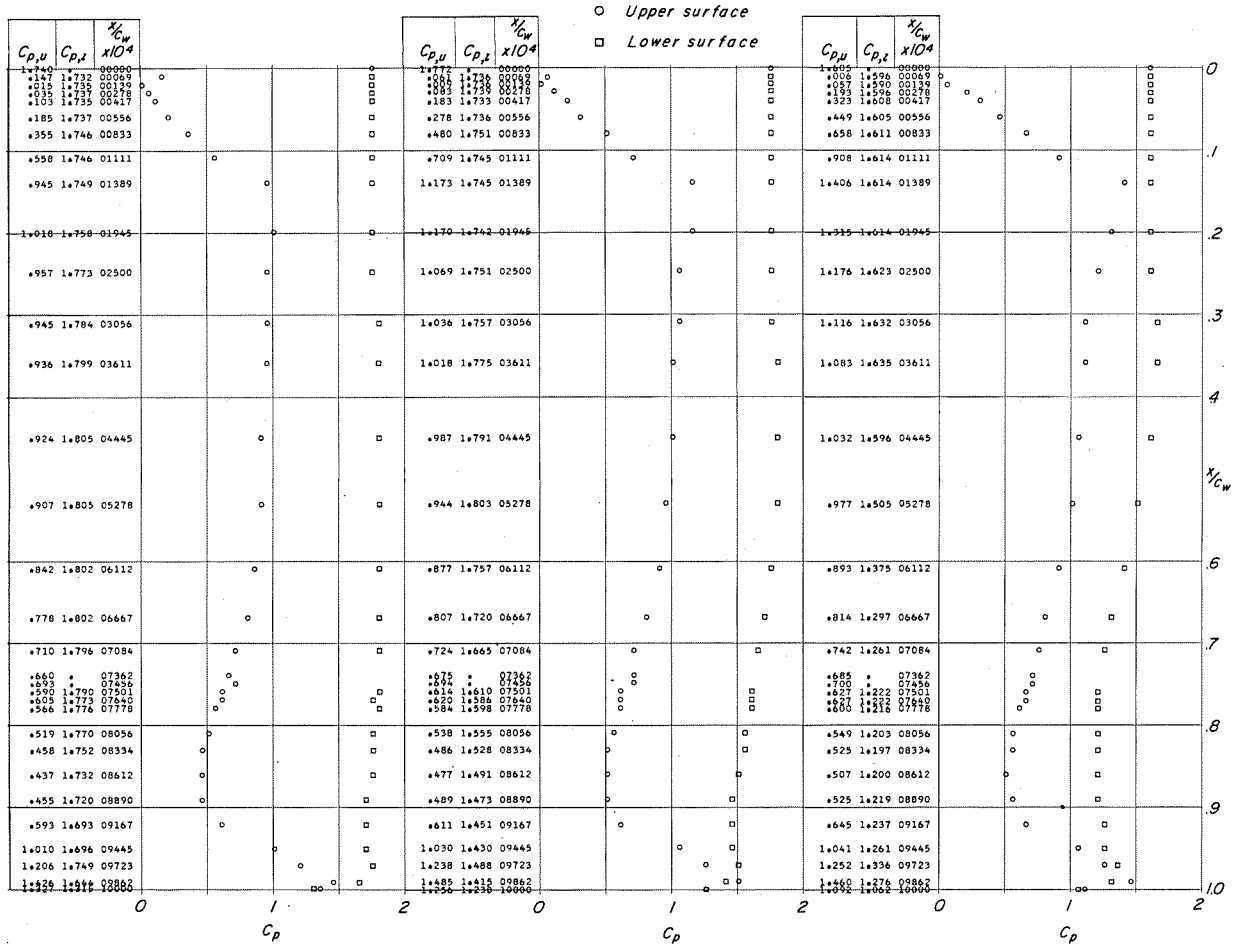
Figure 26.- Continued.



(h) $\alpha = 20^\circ$.

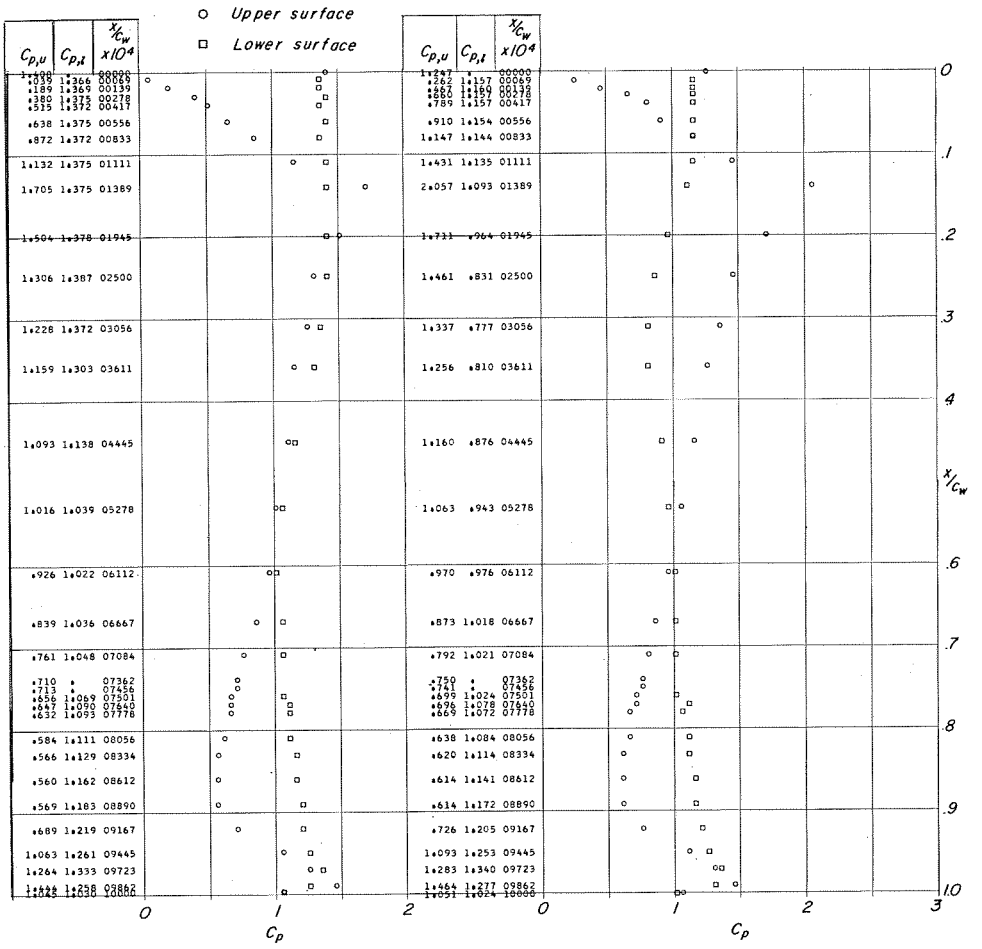
(i) $\alpha = 24^\circ$.

Figure 26.- Concluded.



(a) $\alpha = -8^\circ$. (b) $\alpha = -4^\circ$. (c) $\alpha = 0^\circ$.

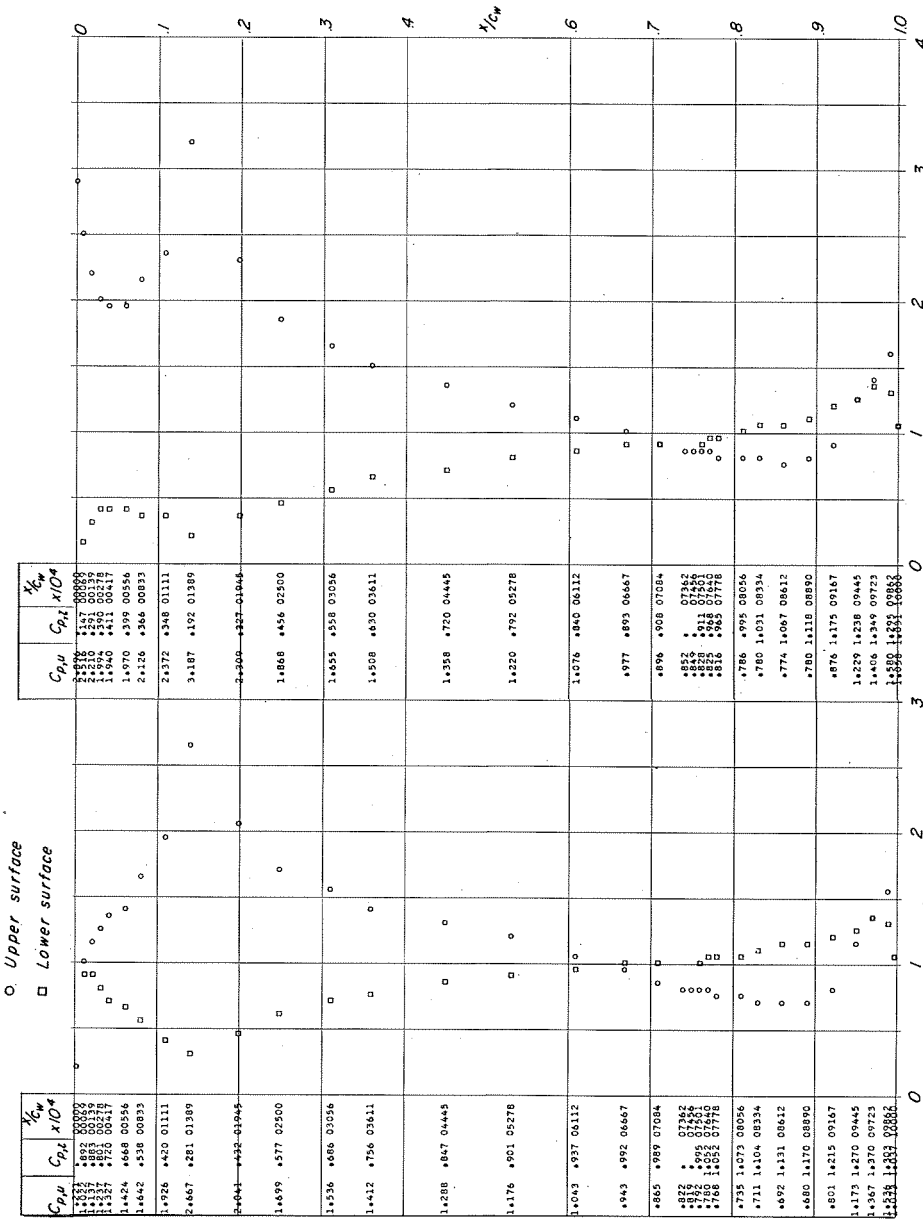
Figure 27.- Chordwise pressure distribution over model. $\delta_N = 30^\circ$; $\delta_f = 0^\circ$; half-span outboard spoiler hinged at 0.90c; tabulated data of points plotted to left of plot.



(d) $\alpha = 4^\circ$.

(e) $\alpha = 8^\circ$.

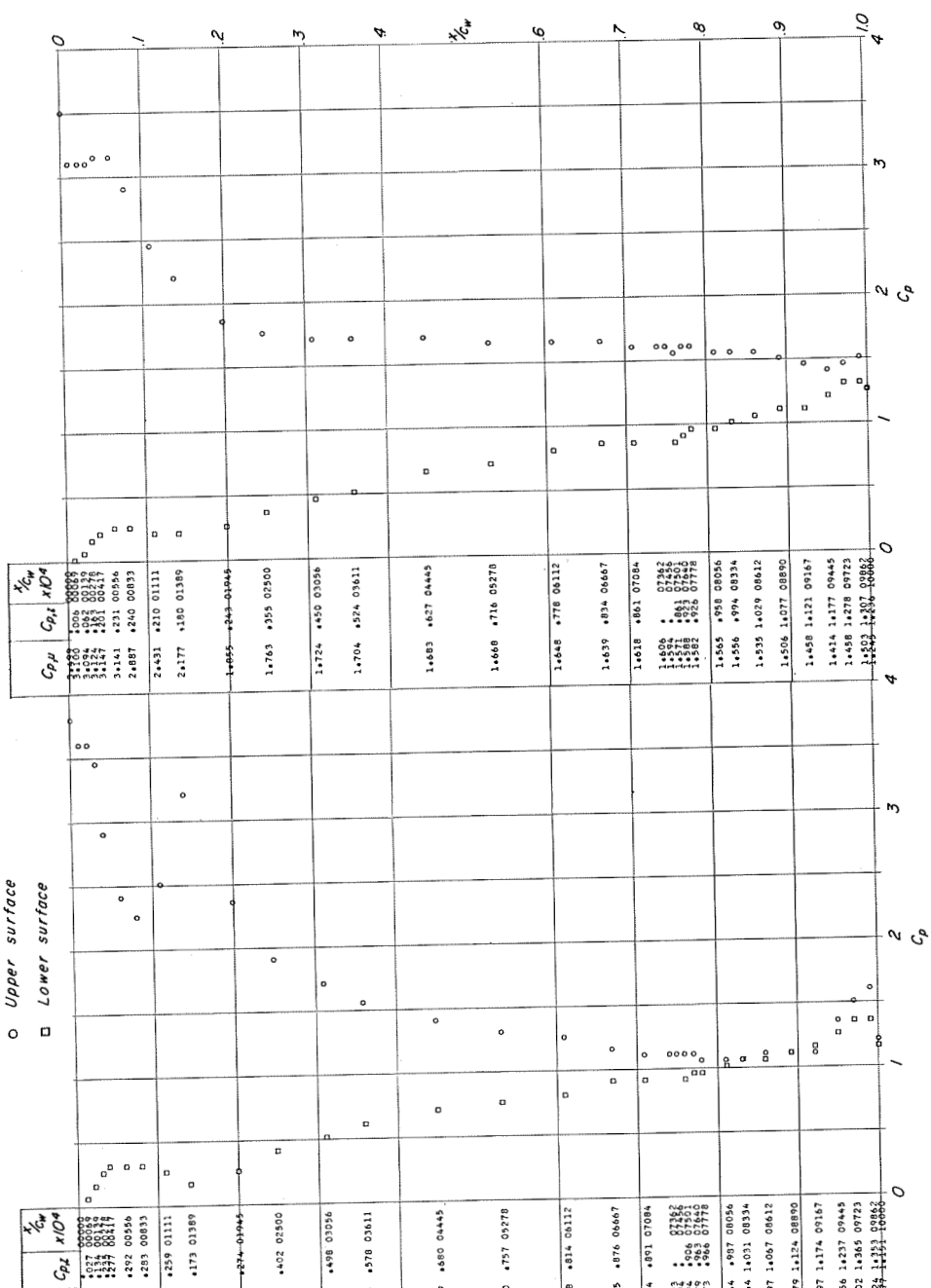
Figure 27.- Continued.



(f) $\alpha = 12^\circ$.

(g) $\alpha = 16^\circ$.

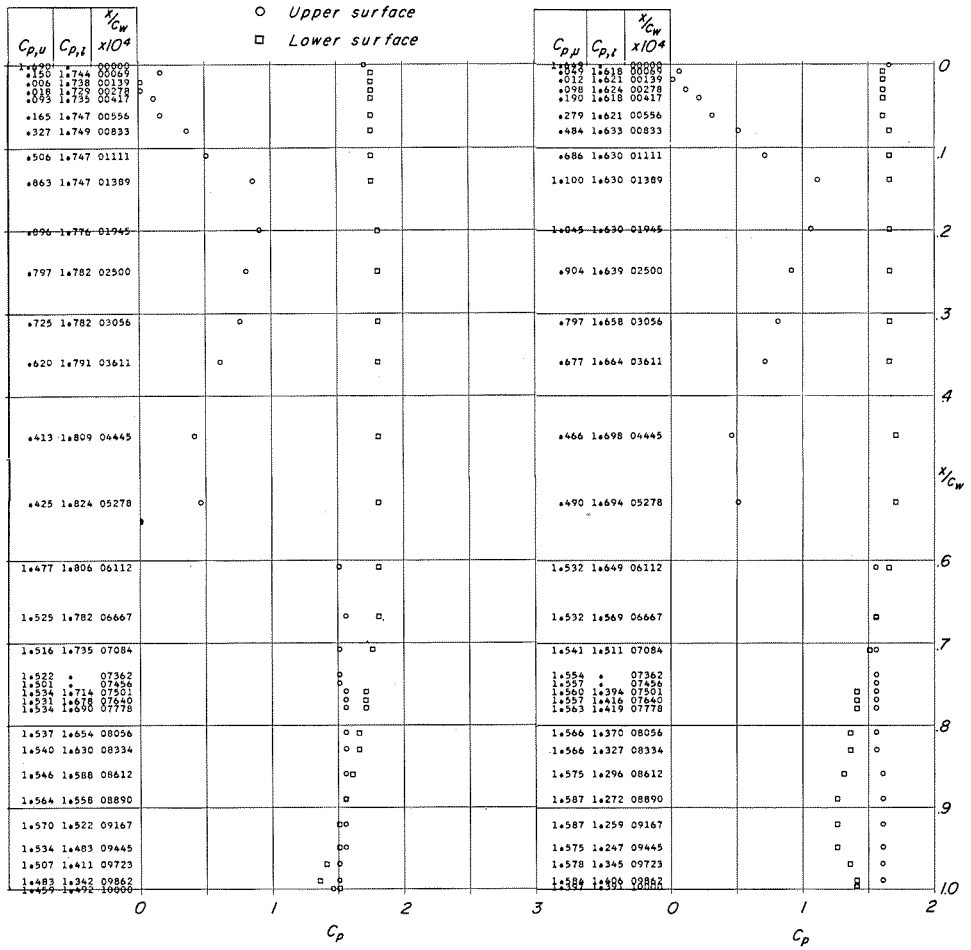
Figure 27.- Continued.



(h) $\alpha = 20°$.

(i) $\alpha = 24°$.

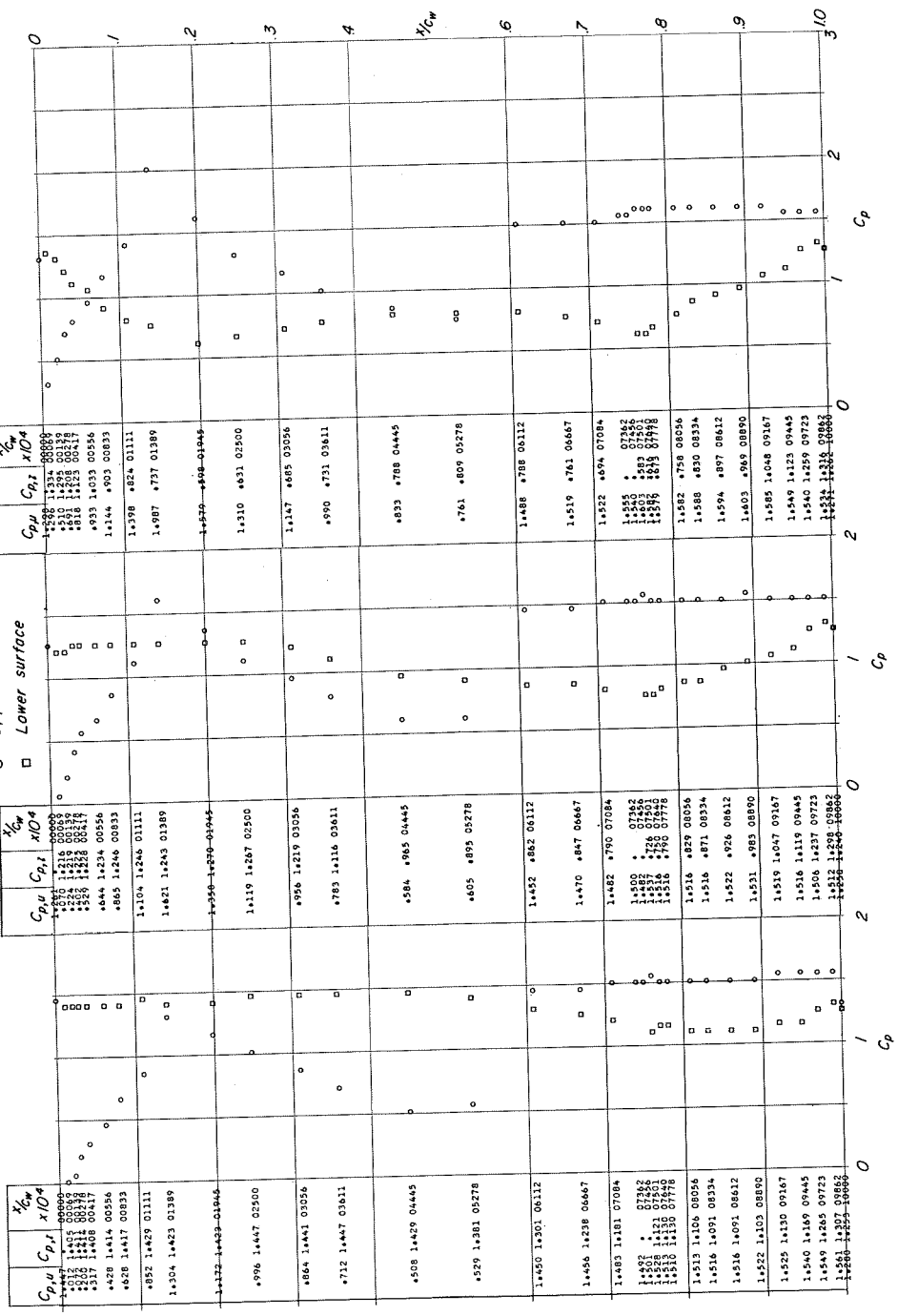
Figure 27.- Concluded.



(a) $\alpha = -8^\circ$.

(b) $\alpha = -4^\circ$.

Figure 28.- Chordwise pressure distribution over model. $\delta_N = 30^\circ$; $\delta_f = 15^\circ$; half-span outboard spoiler hinged at 0.50c; tabulated data of points plotted to left of plot.

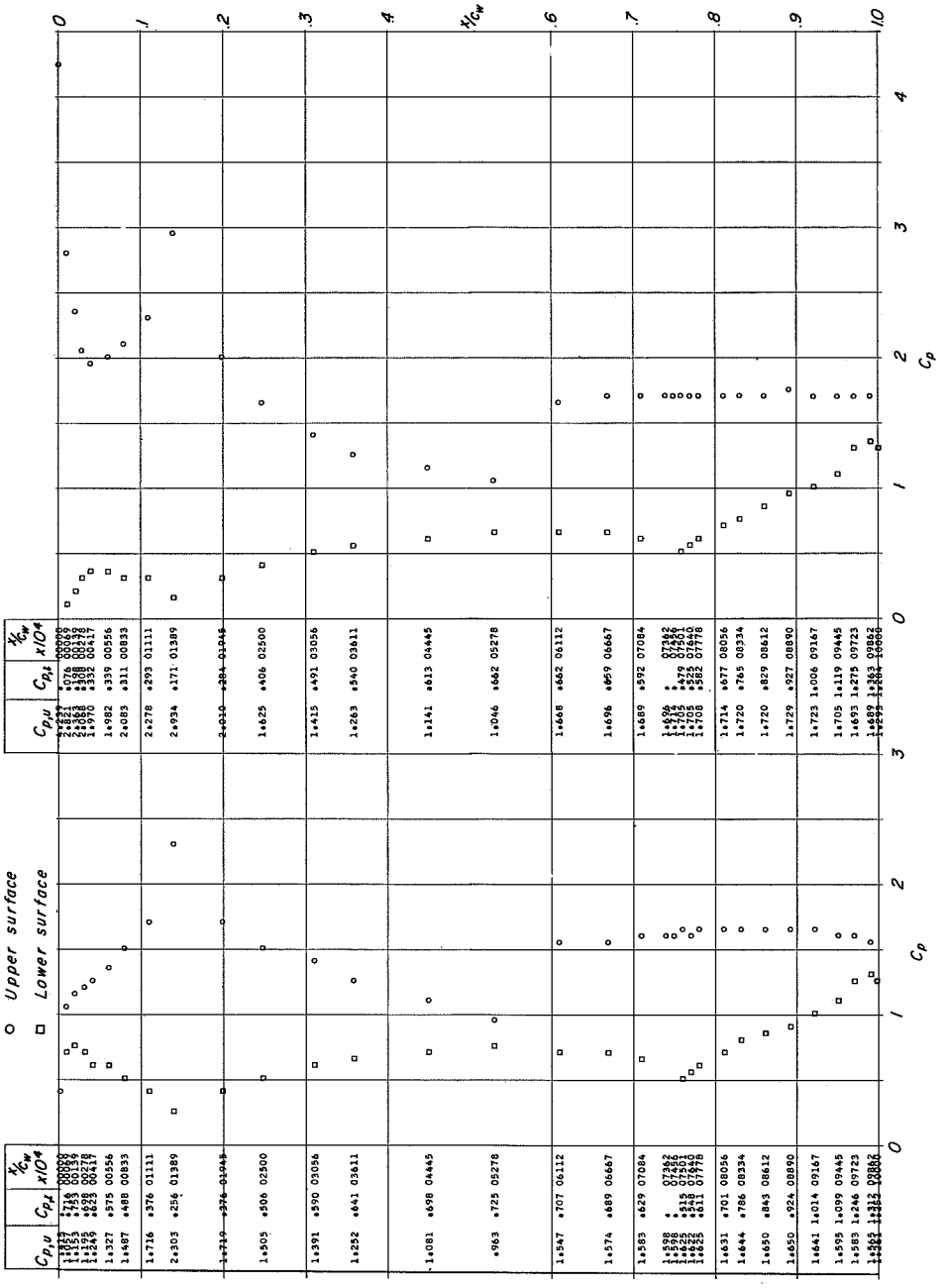


(c) $\alpha = 0°$.

(d) $\alpha = 4°$.

(e) $\alpha = 8°$.

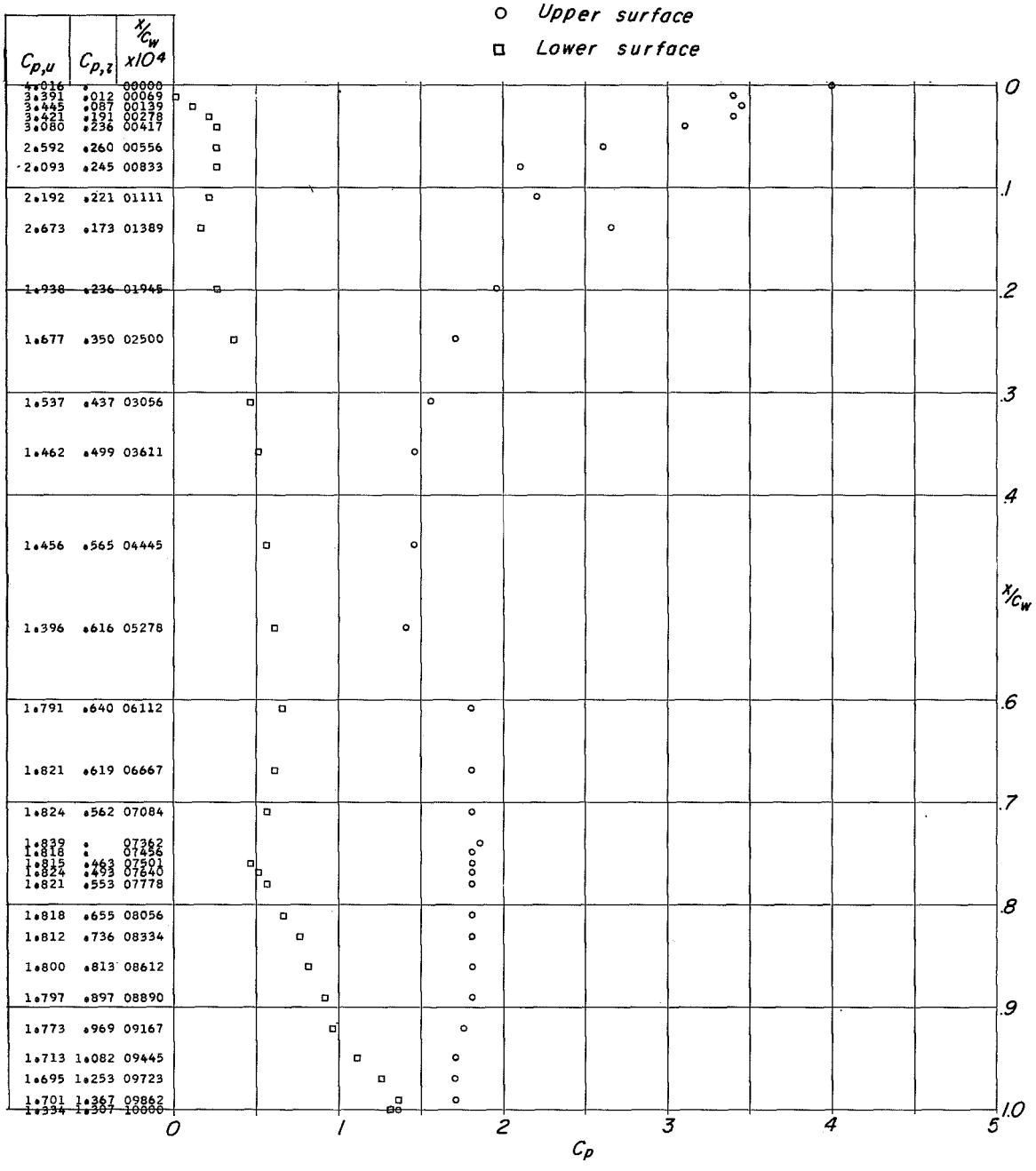
Figure 28.- Continued.



(f) $\alpha = 12°$.

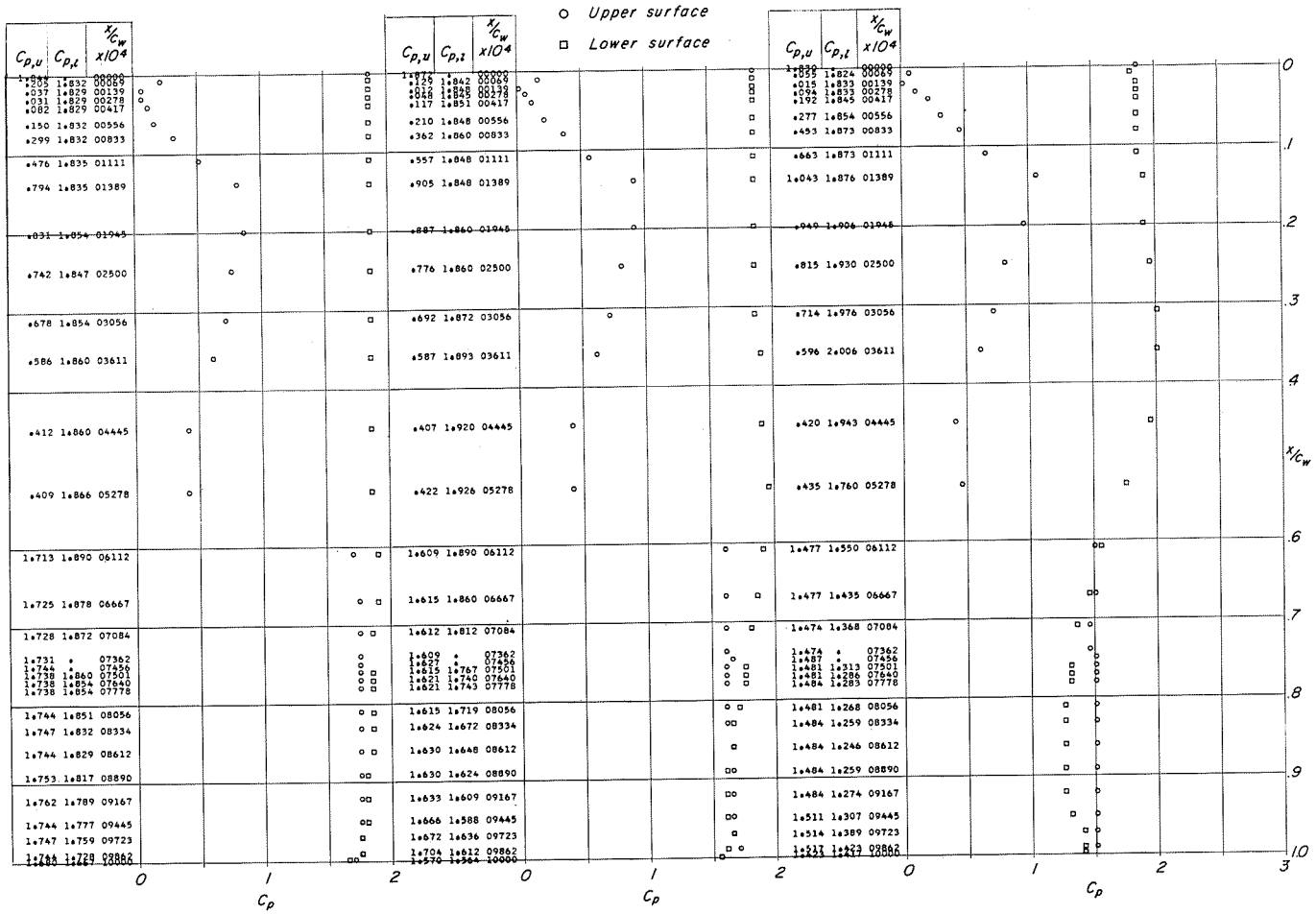
(g) $\alpha = 16°$.

Figure 28.- Continued.



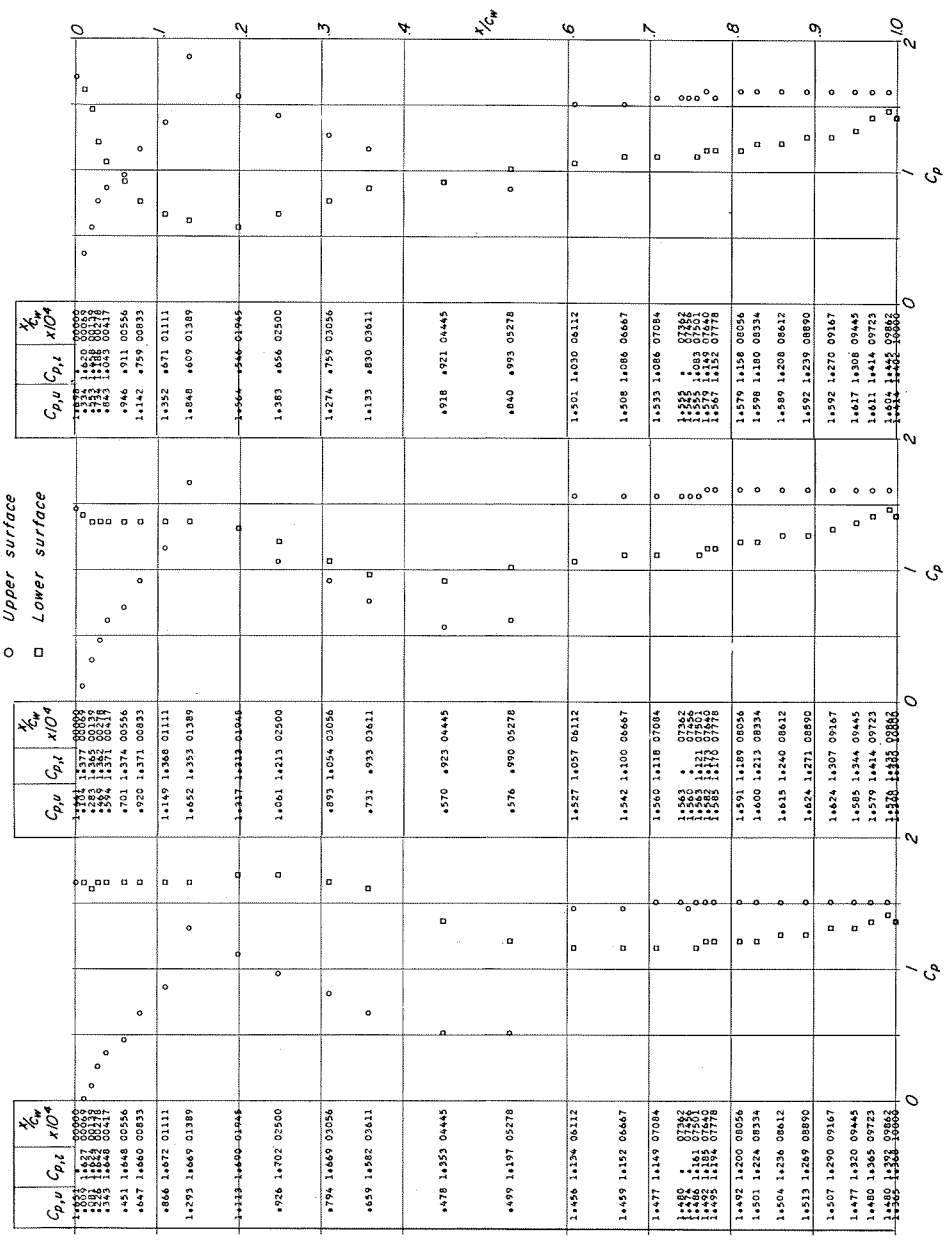
(h) $\alpha = 20^\circ$.

Figure 28.- Concluded.



(a) $\alpha = -8^\circ$. (b) $\alpha = -4^\circ$. (c) $\alpha = 0^\circ$.

Figure 29.- Chordwise pressure distribution over model. $\delta_N = 30^\circ$; $\delta_f = 0^\circ$; full-span outboard spoiler hinged at 0.50c; tabulated data of points plotted to left of plot.

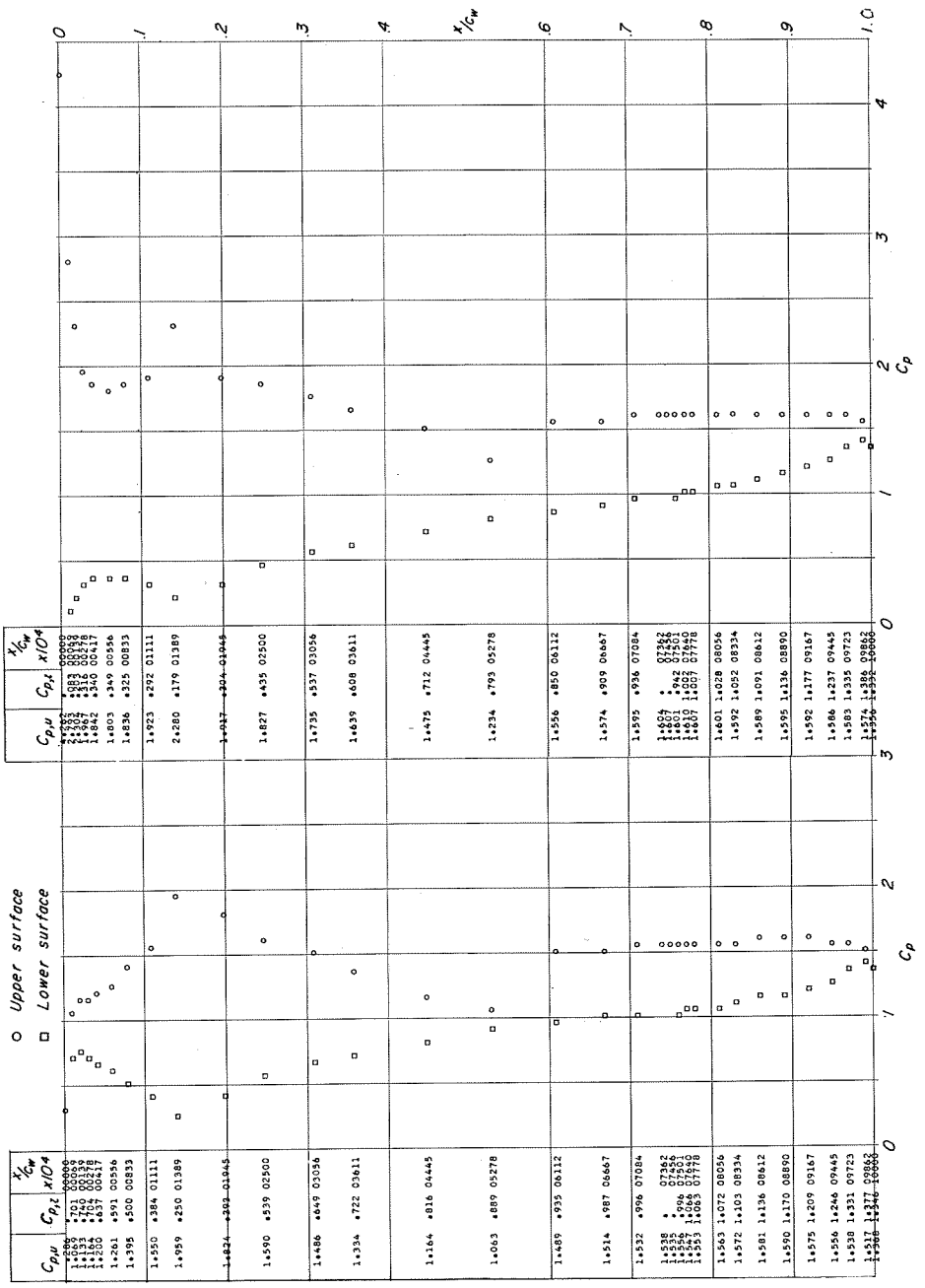


(d) $\alpha = 4^{\circ}$.

(e) $\alpha = 8^{\circ}$.

(f) $\alpha = 12^{\circ}$.

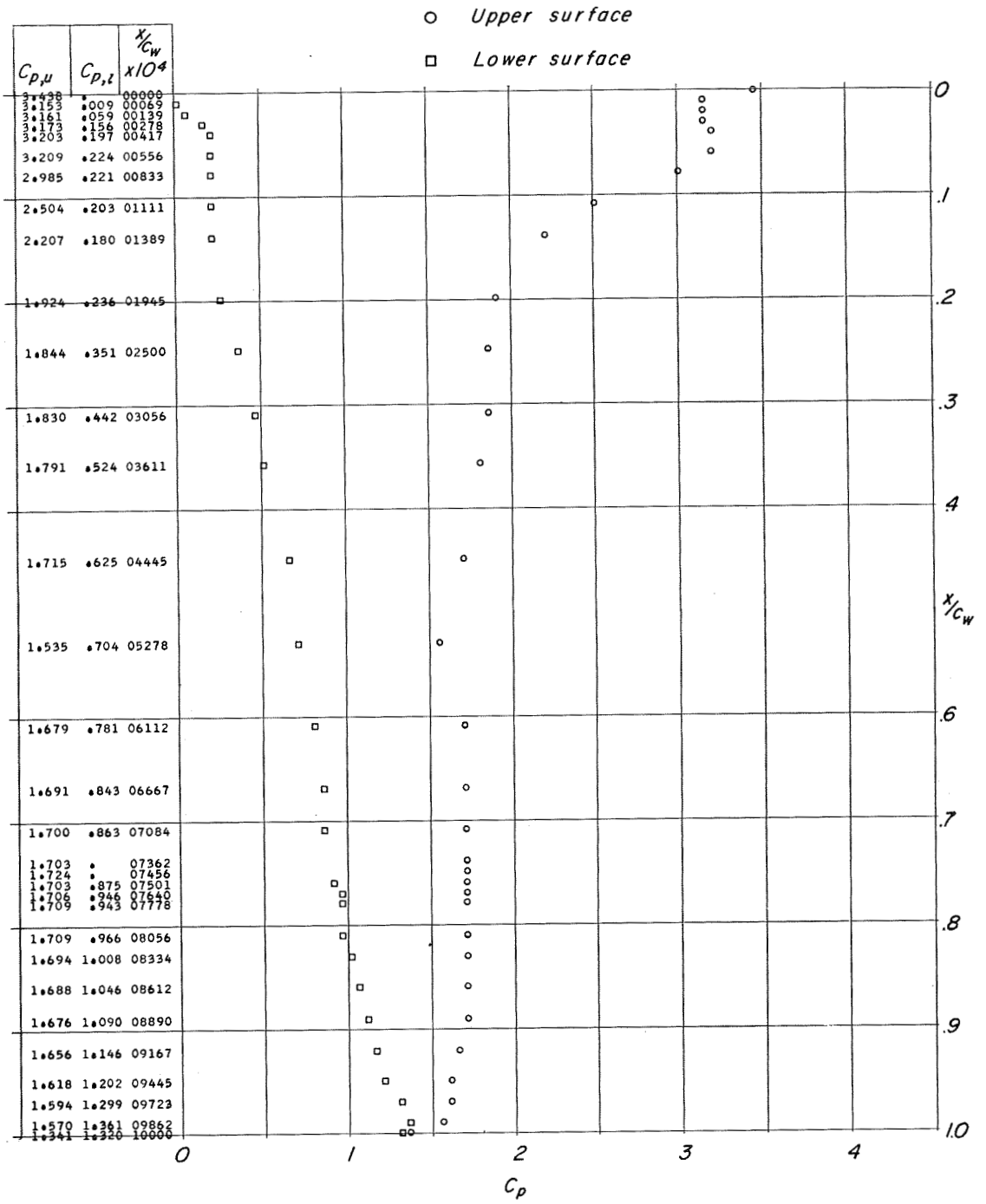
Figure 29.- Continued.



(g) $\alpha = 16^{\circ}$.

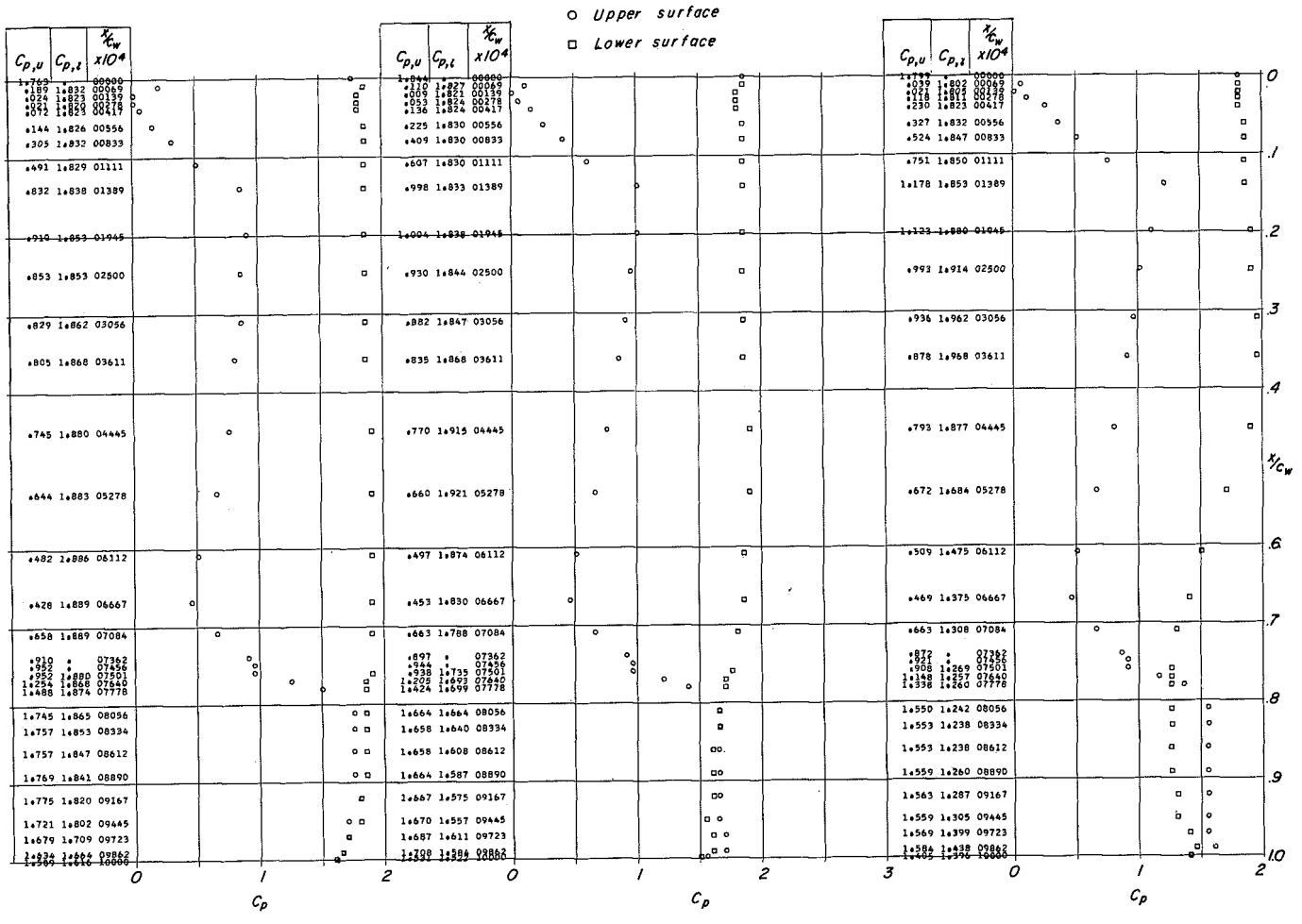
(h) $\alpha = 20^{\circ}$.

Figure 29.- Continued.



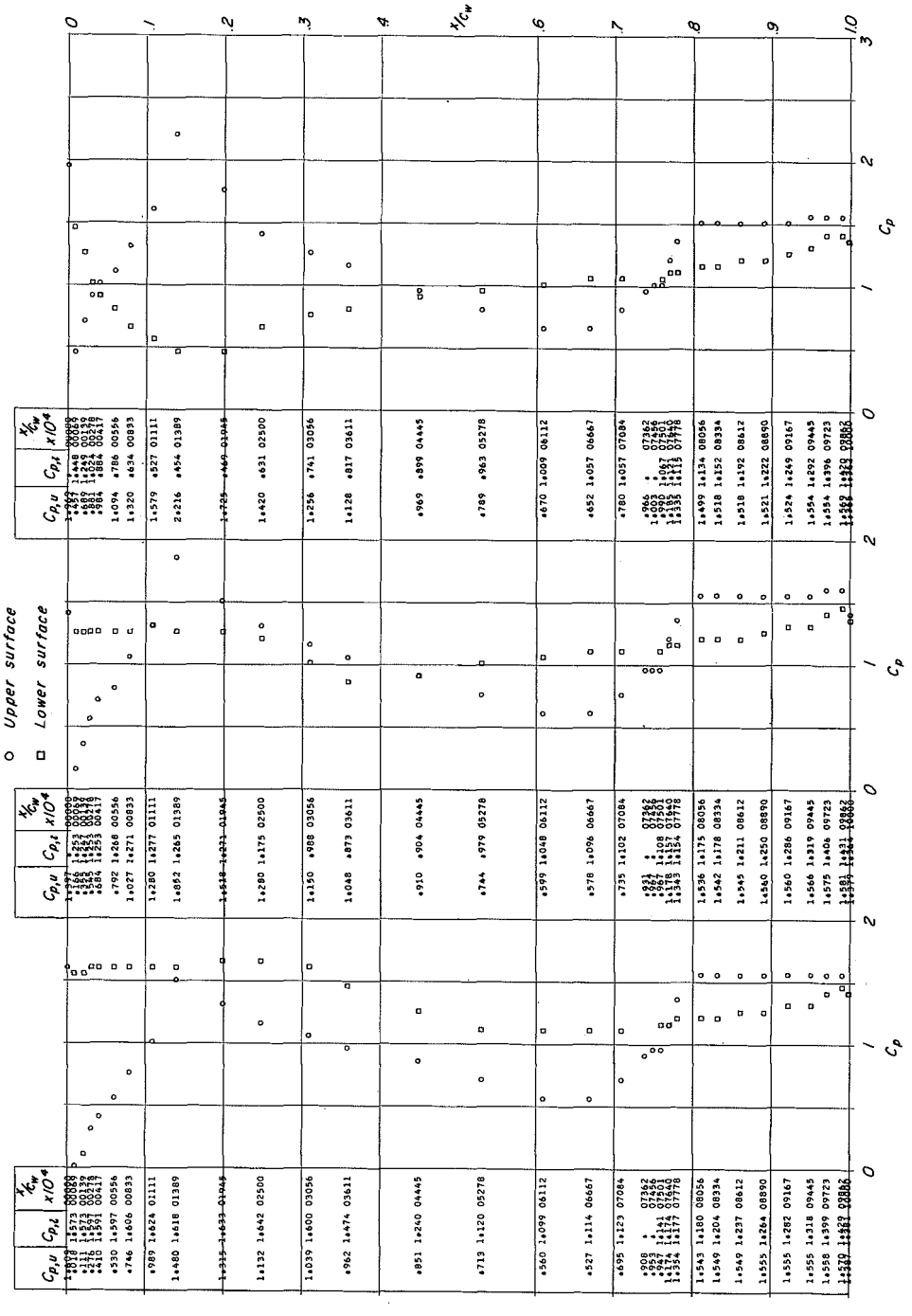
(i) $\alpha = 24^\circ$.

Figure 29.- Concluded.



(a) $\alpha = -8^\circ$. (b) $\alpha = -4^\circ$. (c) $\alpha = 0^\circ$.

Figure 30.- Chordwise pressure distribution over model. $\delta_N = 30^\circ$; $\delta_f = 0^\circ$; full-span outboard spoiler hinged at 0.70c; tabulated data of points plotted to left of plot.

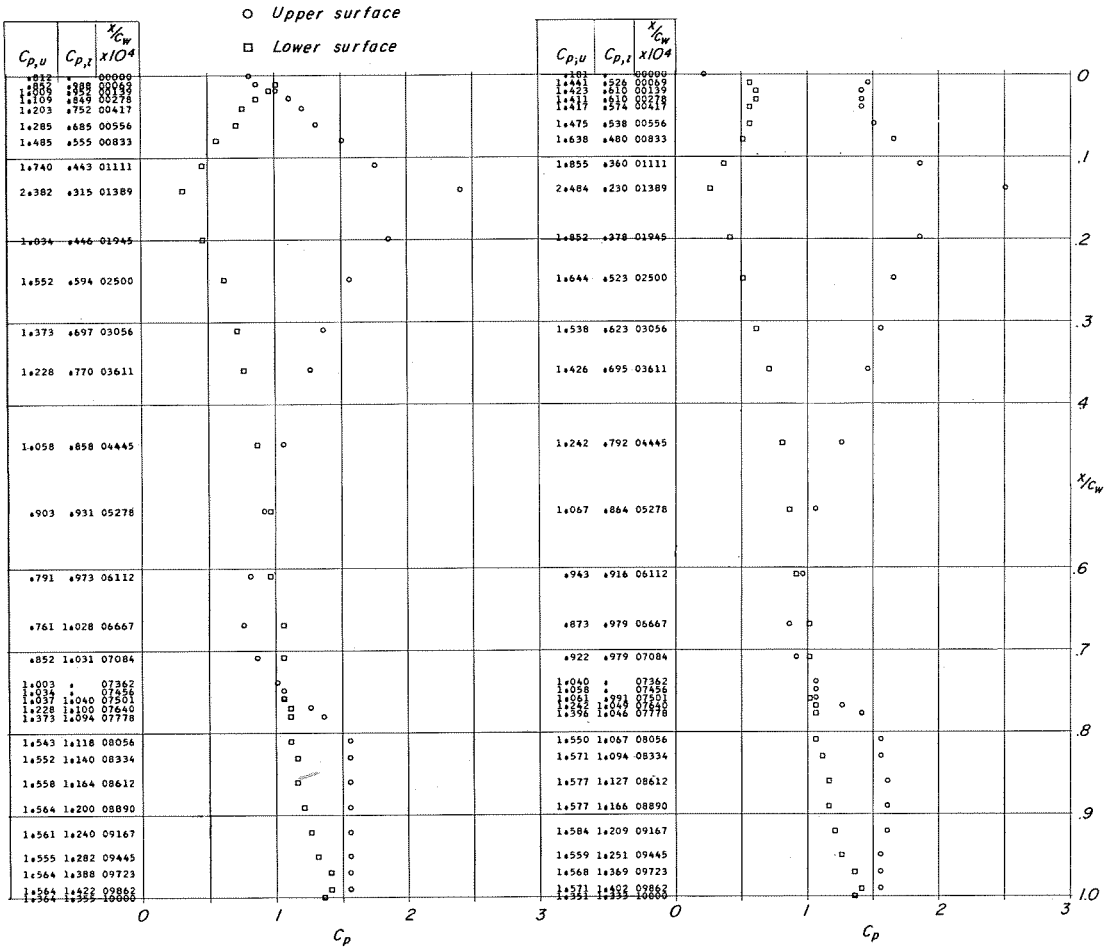


(d) $\alpha = 4^\circ$.

(e) $\alpha = 8^\circ$.

(f) $\alpha = 12^\circ$.

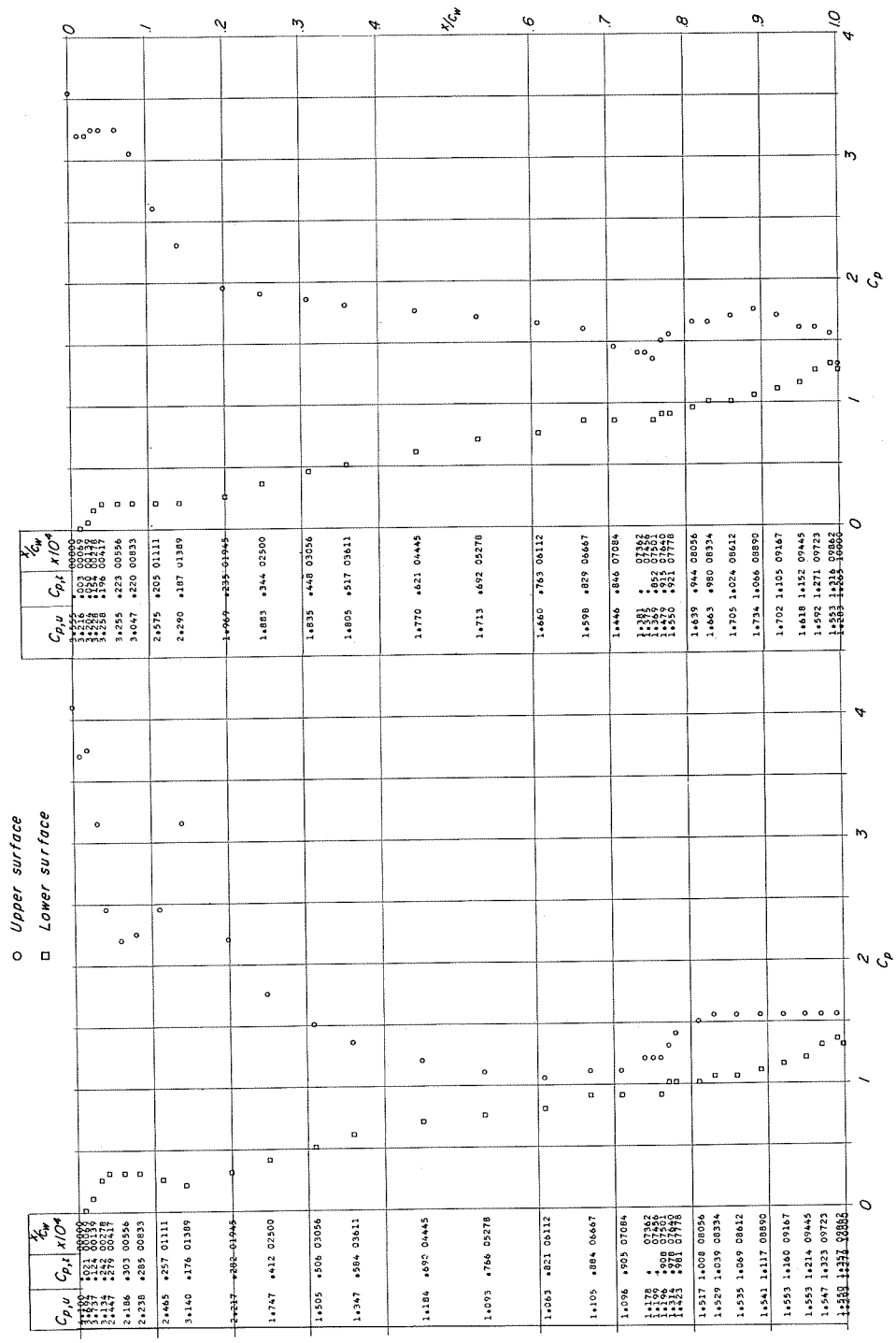
Figure 30.- Continued.



(g) $\alpha = 14^\circ$.

(h) $\alpha = 16^\circ$.

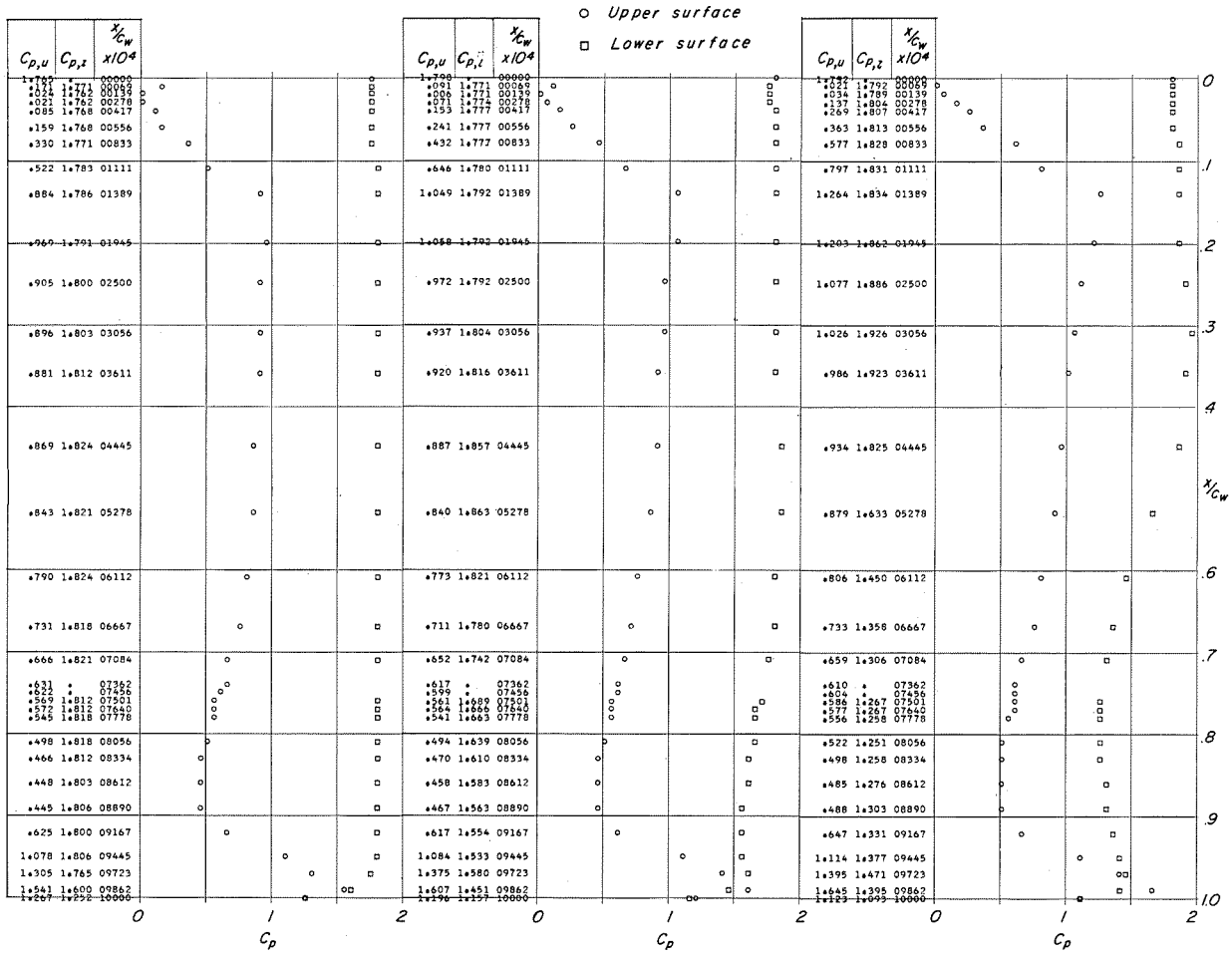
Figure 30.- Continued.



(i) $\alpha = 20^{\circ}$.

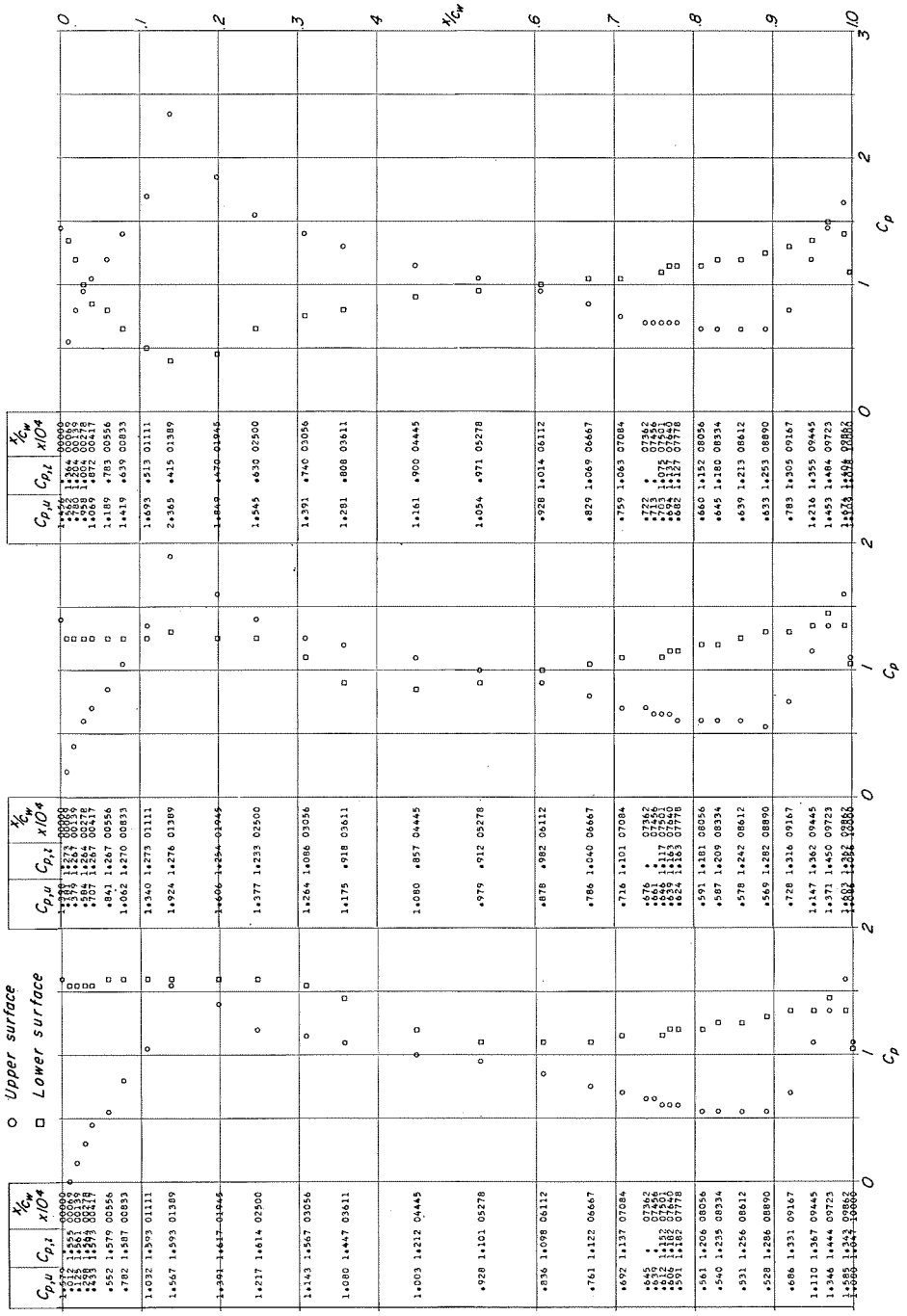
(j) $\alpha = 24^{\circ}$.

Figure 30.- Concluded.



(a) $\alpha = -8^\circ$. (b) $\alpha = -4^\circ$. (c) $\alpha = 0^\circ$.

Figure 31.- Chordwise pressure distribution over model. $\delta_N = 30^\circ$; $\delta_f = 0^\circ$; full-span outboard spoiler hinged at 0.90c; tabulated data of points plotted to left of plot.

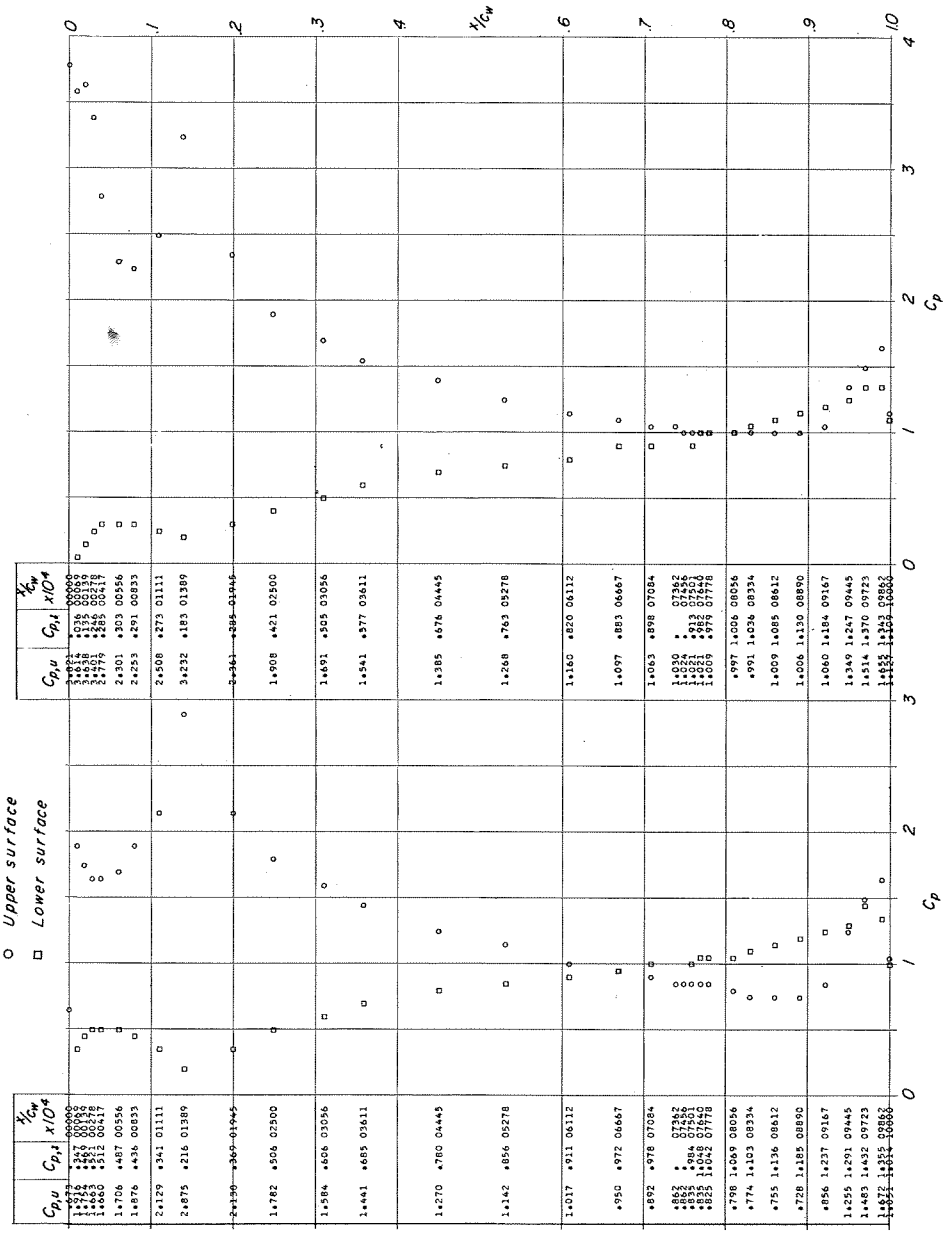


(d) $\alpha = 4^{\circ}$.

(e) $\alpha = 8^{\circ}$.

(f) $\alpha = 12^{\circ}$.

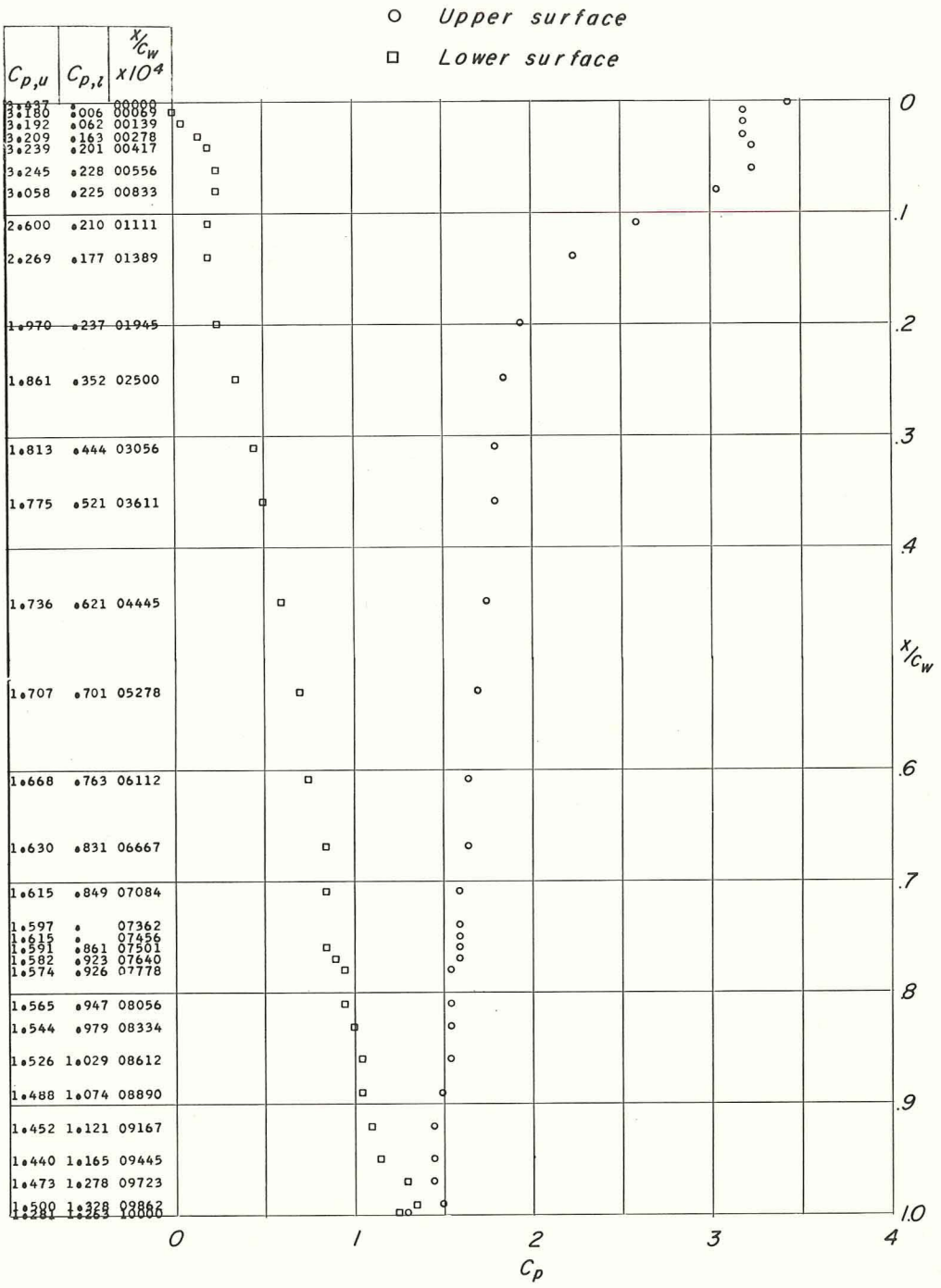
Figure 31.- Continued.



(g) $\alpha = 16^\circ$.

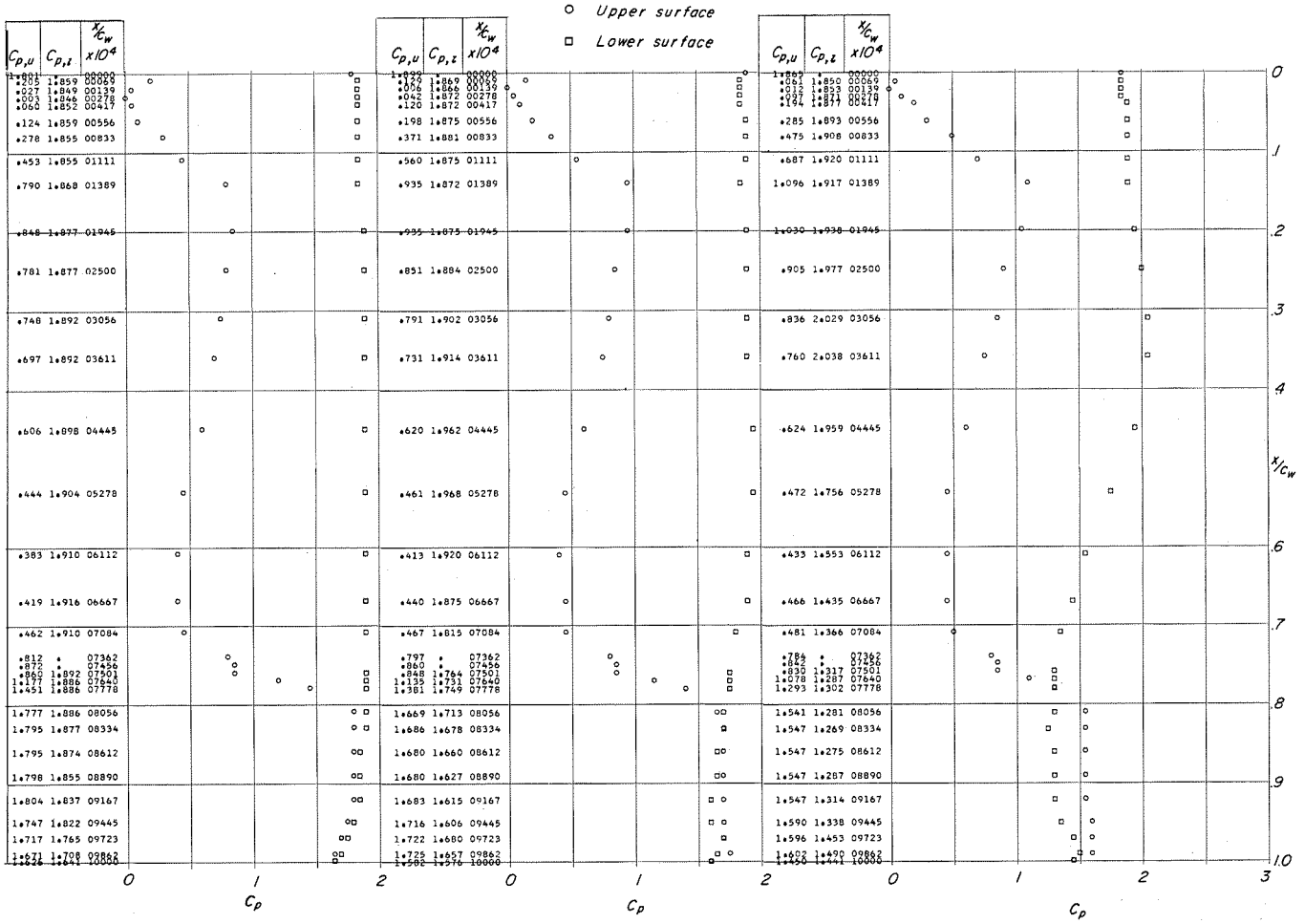
(h) $\alpha = 20^\circ$.

Figure 31.- Continued.



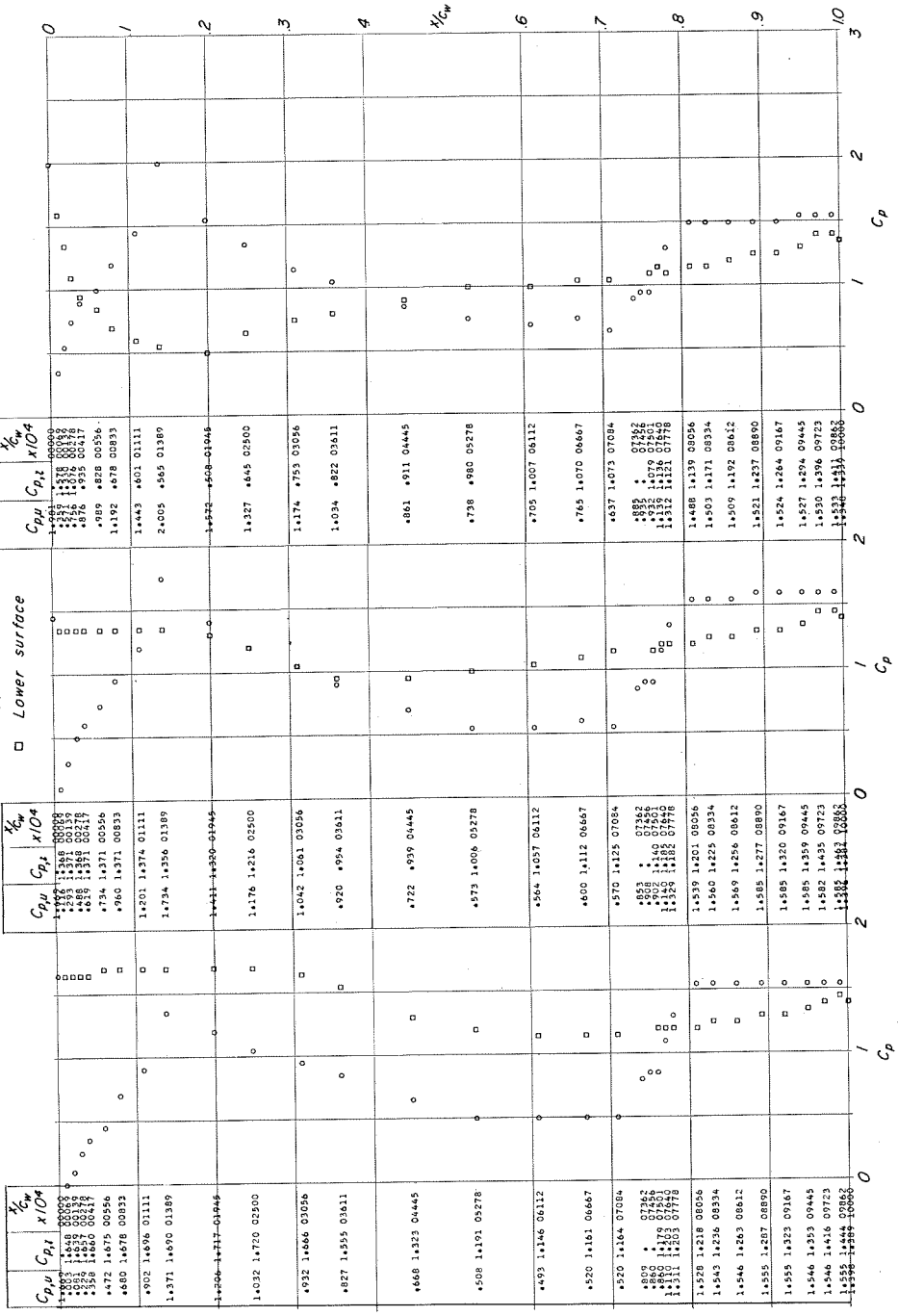
(i) $\alpha = 24^\circ$.

Figure 31.- Concluded.



(a) $\alpha = -8^\circ$. (b) $\alpha = -4^\circ$. (c) $\alpha = 0^\circ$.

Figure 32.- Chordwise pressure distribution over model. $\delta_N = 30^\circ$; $\delta_f = 0^\circ$; full-span outboard spoiler hinged at 0.90c (reversed mounted); tabulated data of points plotted to left of plot.

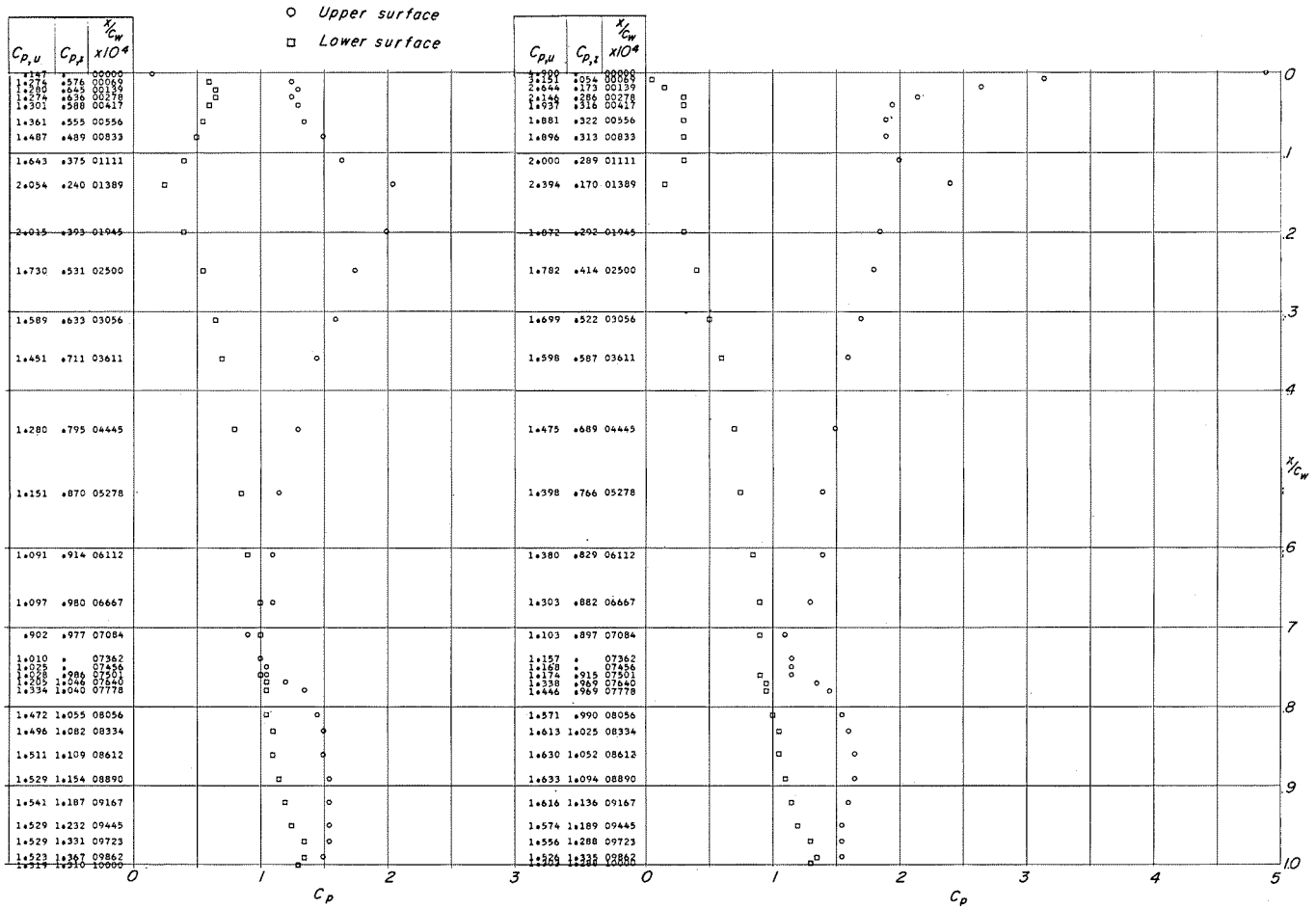


(d) $\alpha = 4^\circ$.

(e) $\alpha = 8^\circ$.

(f) $\alpha = 12^\circ$.

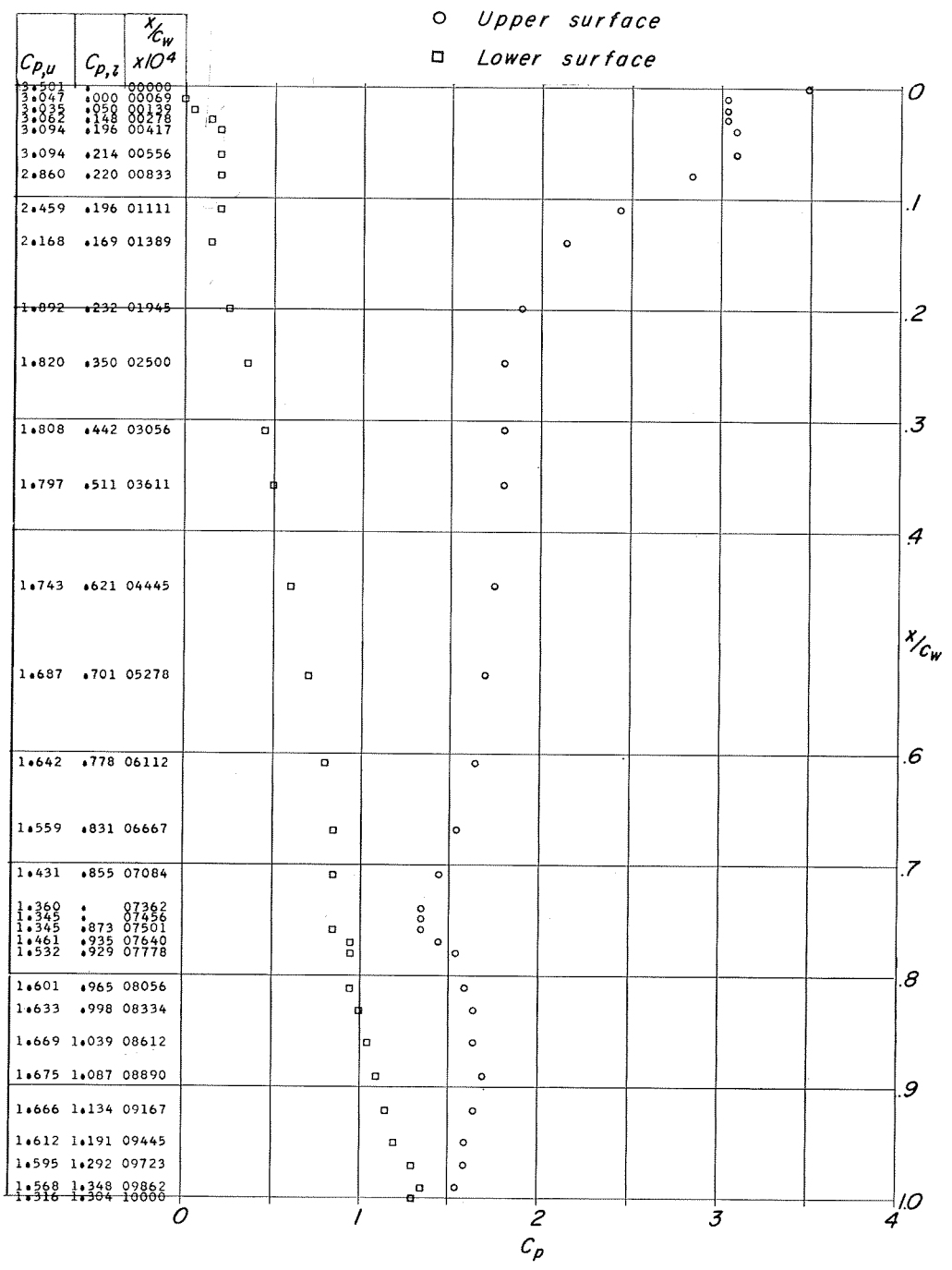
Figure 32.- Continued.



(g) $\alpha = 16^\circ$.

(h) $\alpha = 20^\circ$.

Figure 32.- Continued.



(i) $\alpha = 24^\circ$.

Figure 32.- Concluded.