NACA

RESEARCH MEMORANDUM

AN INVESTIGATION AT HIGH SUBSONIC SPEEDS OF THE PRESSURE DISTRIBUTIONS ON A 45° SWEPTBACK VERTICAL TAIL IN SIDESLIP WITH AND WITHOUT A 45° SWEPTBACK HORIZONTAL TAIL LOCATED ON THE FUSELAGE CENTER LINE

By Harleth G. Wiley and William C. Moseley, Jr.

Langley Aeronautical Laboratory
Langley Field, Va.

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

WASHINGTON

November 2, 1954

Classification cancelled (or changed to Unclassified)

By Auth Nasa Tech Pub Announcement #205
(OFFICER AUTHORIZED TO CHANGE)

By 25 Aug 56

NK

GRADE OF OFFICER MAKING CHANGE)

5 April 61
DATE

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

RESEARCH MEMORANDUM

AN INVESTIGATION AT HIGH SUBSONIC SPEEDS OF THE PRESSURE DISTRIBUTIONS ON A 45° SWEPTBACK VERTICAL TAIL IN SIDESLIP WITH AND WITHOUT A 45° SWEPTBACK HORIZONTAL TAIL LOCATED ON THE FUSELAGE CENTER LINE

By Harleth G. Wiley and William C. Moseley, Jr.

SUMMARY

An investigation was made in the Langley high-speed 7- by 10-foot tunnel at high subsonic speeds and several angles of attack of the chordwise pressure distribution at six spanwise stations on a 45° sweptback, untapered vertical tail in sideslip. The vertical tail was mounted on a fuselage and tests were made with and without a 45° sweptback untapered horizontal tail mounted on the fuselage center line. The horizontal and vertical tails had NACA 65A010 airfoils normal to the leading edge and had aspect ratios of 4.0 and 2.0, respectively.

Results indicated that the presence of the horizontal tail slightly increased the value of section normal-force coefficients on the vertical tail except at angles of sideslip above about 12° but did not materially alter the nature of the load distribution.

INTRODUCTION

The National Advisory Committee for Aeronautics has undertaken a research program to determine the aerodynamic loadings on vertical tails as they are affected by various design parameters and maneuver attitudes. Calculated subsonic loadings and resulting stability derivatives of unswept and 45° sweptback tail surfaces in steady roll and sideslip at low speeds are presented in reference 1 for surfaces of various aspect ratios and horizontal-tail heights. The effects of vertical location of the horizontal tail on the aerodynamic characteristics in sideslip of an unswept, untapered tail assembly were determined experimentally and

[redacted]

theoretically at low speeds and at high subsonic speeds and presented in references 2 and 3, respectively.

The present experimental investigation was made in the Langley high-speed 7- by 10-foot tunnel to determine the aerodynamic loadings in sideslip at several angles of attack at high subsonic speeds on an untapered 45° sweptback vertical tail mounted on a fuselage with and without an untapered 45° sweptback horizontal tail. The horizontal tail was mounted on the fuselage center line at 0 percent vertical tail span. The vertical and horizontal tails had NACA 65A010 airfoils normal to the leading edges and had aspect ratios of 2.0 and 4.0, respectively. Chordwise pressure distributions were obtained on the vertical tail at stations of 20.0, 30.0, 45.0, 70.0, 85.0, and 93.1 percent vertical tail span.

Tests were made at 0°, 4°, and 12° angle of attack, through an angle-of-sideslip range of -2° to about 23°, and over a Mach number range of 0.60 to 0.95. Reynolds number for the tests, based on the mean aerodynamic chord of the vertical tail, varied with Mach number from about 1.9×10^{6} to 2.4×10^{6}.

COEFFICIENTS AND SYMBOLS

The results presented in this paper are referred to the standard body axes as shown in figure 1 and the coefficients and symbols used are defined as follows:

c_n section normal-force coefficient of vertical tail, $\dfrac{\text{Section normal force}}{qc}$

c_m section moment coefficient of vertical tail referred to 0.25c, $\dfrac{\text{Section moment}}{qc^2}$

C_N normal-force coefficient of vertical tail,

$$\sum\left(c_{n_1}b_1'c_1 + \ldots + c_{n_6}b_6'c_6\right)\frac{1}{S}$$

C_B root-bending-moment coefficient of vertical tail about intersection of vertical tail and fuselage,

$$\sum\left(c_{n_1}b_1'l_1c_1 + \ldots + c_{n_6}b_6'l_6c_6\right)\frac{1}{bS}$$

P pressure coefficient, $\dfrac{p_l - p_o}{q}$

[redacted]

p_l local static pressure, lb/sq ft

p_o free-stream static pressure, lb/sq ft

q free-stream dynamic pressure, $\frac{\rho V^2}{2}$, lb/sq ft

ρ mass density of air, slugs/cu ft

V free-stream velocity, ft/sec

M Mach number

R Reynolds number

α angle of attack, deg

β angle of sideslip, deg

$\Delta\beta$ incremental change of angle of sideslip due to vertical-tail load, deg

S exposed area of vertical tail, sq ft

c local chord of vertical tail, ft

$\bar{c}$ mean aerodynamic chord of vertical tail, ft

b_v span of vertical tail (measured from center line of fuselage to tip of vertical tail), ft

b exposed span of vertical tail (measured from intersection of fuselage and vertical tail to tip of vertical tail), ft

b' exposed local span segment, ft

l distance from intersection of fuselage and vertical tail to centroid of exposed local span segment, ft

z vertical distance measured along Z-axis, in.

Subscripts:

1,2, . . . span station indicated

h horizontal

v vertical

[redacted]

MODEL AND APPARATUS

A drawing of the swept-tail model used in the investigation is presented in figure 2 with a photograph of the model assembly shown in figure 3.

The untapered, 45° sweptback horizontal and vertical surfaces had NACA 65A010 airfoils normal to the leading edge and had aspect ratios of 4.0 and 2.0, respectively. The tail surfaces were constructed of a steel core overlaid with a glass fiber and transparent plastic finish to obtain the airfoil contour.

Pressure tubes were installed in the plastic surface covering of the vertical tail along constant percentage chord lines at locations shown in table I. Data were first obtained at the outermost span station $(0.931b_V)$, the tubes were then sealed and orifices were drilled at the next inboard station $(0.850b_V)$, and so on. Data were thus obtained for all spanwise stations at progressively inboard locations on the vertical tail.

The tail surfaces were mounted on a cylindrical body fabricated of sheet aluminum with an ogival-shaped nosepiece (figs. 2 and 3).

Tests were made with the models mounted on the sting support of the Langley high-speed 7- by 10-foot tunnel with the vertical tail mounted in a horizontal plane (fig. 3).

The chordwise pressure distributions on the vertical tail were obtained by directly photographing the pressures as projected by a calibrated, pneumatic-optical system. The system comprised a series of pressure-indicating units made up of a mirror attached to a diaphragm-type pressure cell. One side of the pressure cell responded to local orifice static pressure p_l with the other side referenced to free-stream static pressure p_o such that the pressure-cell diaphragm deflected in proportion to the pressure differential $p_l - p_o$. By means of the mirror, a "pin point" of light was projected on a calibrated camera screen such that the height of the projected light was proportional to $p_l - p_o$. Each pressure orifice on the left and right surfaces of the airfoil was connected to a separate indicator unit with the horizontal spacing of the indicator lights on the screen proportional to the chordwise spacing of the orifices on the airfoil (table I). Direct photographs were thus obtained of simultaneous pressures which existed on both surfaces of the vertical tail.

The section characteristics, normal force and moment, were obtained with an electrical pressure integrator which employed calibrated differential pressure cells to measure electrically the difference in pressure between orifices located at common chordwise positions on each side of the vertical tail. The output from each pressure cell was "weighted" by resistors to account for that linear portion of the airfoil chord over which the subject pressure was considered effective. The total "weighted" output of all cells was fed to a servo-operated, self-balancing Wheatstone bridge circuit which directly indicated the summation of all pressures over the airfoil chord. Section normal force was thus obtained for each span station in terms of the product of c_n times q for unit chord and span.

Section moment was similarly obtained as qc_m, by taking into account the distance from the moment reference (0.25c for these tests) to the centroid of the effective areas of each orifice for the determination of the proper moment "weighting" factors (table I). A more detailed description of the principles involved in the design of the integrator is presented in reference 4.

TESTS AND CORRECTIONS

The tests were made in the Langley high-speed 7- by 10-foot tunnel through a Mach number range of 0.60 to 0.95. Reynolds number for the tests, based on the mean aerodynamic chord of the vertical tail, varied from about 1.9×10^6 to 2.4×10^6 (fig. 4). Tests were made over an angle-of-sideslip range of -2° to 23° at angles of attack of 0°, 4°, and 12°.

Blockage corrections, computed by the method of reference 5, were derived as an incremental correction to Mach number.

No corrections were made to the data to account for the aeroelastic distortion of the vertical tail under load. In order to determine the general magnitude and nature of the distortion on the vertical tail during tests, however, static tests were made using a span loading representative of the high loads obtained at high sideslip angles. In addition, the theoretical deflections of the tail were computed according to the method of reference 6. (The span loading used for the static tests and the theoretical computations simulated the loading on the vertical tail in the presence of the horizontal tail as obtained from wind-tunnel tests at 0° angle of attack, 16° angle of sideslip, and a Mach number of 0.95 (fig. 5(a)). The static loadings were arbitrarily considered applied at 27 percent vertical tail chord.) The experimental and theoretical deflections are presented in figure 5 in terms of the change of angle of sideslip due to load $\Delta\beta$ over the vertical-tail span. As shown in figure 5(b), the maximum value of $\Delta\beta$ obtained from static tests was about 0.9° and reasonable approximations of the change in angle of sideslip over the tail due to load can be calculated by the methods of reference 6.

Deflection of the sting-support system under load was small and was neglected.

ACCURACY OF DATA

The accuracy of the original data, section normal-force coefficient c_n, section moment coefficient c_m, and pressure coefficient P, are direct functions of the mechanical accuracies of the pressure-integrating and pressure-diagram machines. The data are believed accurate within the following limits:

c_n	±0.005
c_m	±0.001
P	±0.03

REDUCTION OF DATA

Integrated chordwise loadings were obtained by the pressure-integrating machine on the assumption that a square-wave loading with parabolic fairings at the leading and trailing edges closely approximated the actual chordwise loading (ref. 4). Electrical resistor "weighting factors" used in the machine for the chordwise integrations are presented in table I.

Since section normal force and moment were obtained directly from the pressure-integrating machine in terms of qc_n and qc_m for unit chord, the coefficients c_n and c_m were simply obtained by dividing machine results by the dynamic pressure q.

In order to obtain normal-force coefficient C_N and root-bending-moment coefficient C_B, a mathematical integration of the variation of section normal-force coefficient over the exposed vertical-tail span was performed. The assumption was made that a square-wave loading over the span reasonably approximated the actual span loading. The value of c_n at each span station was considered effective over that segment of the tail span which extended half way to the adjacent span stations or to the tail tip or root as appropriate. Actual numerical values of the span segments b' assigned for each span station are presented in figure 6. A summation of the product of c_n and the appropriate span segment b' for each of the span stations results in the normal-force coefficient

$$C_N = \sum\left(c_{n1}b_1'c_1 + \ldots + c_{n6}b_6'c_6\right)\frac{1}{S}$$

Similarly, root-bending-moment coefficient C_B was obtained by assigning a moment arm l which extended from the moment reference (junction of the vertical tail and the fuselage) to the centroid of the exposed span segment for each span station (fig. 6). Thus

$$C_B = \sum\left(c_{n_1}b_1'l_1c_1 + \ . \ . \ . + c_{n_6}b_6'l_6c_6\right)\frac{1}{bS}$$

RESULTS AND DISCUSSION

In order to present the results of this investigation in the most usable form, complete tables of all section coefficients obtained and pressure diagrams at representative span stations and test conditions are presented for the vertical tail with and without the horizontal tail. See tables II to VII. In addition, the results are summarized in terms of span loading, section moment coefficient, and normal-force and root-bending-moment coefficients with short discussions of these parameters as pertinent.

Presented in figure 7 are the spanwise variations of c_n over the vertical tail with and without the horizontal tail for various angles of sideslip and Mach number at angles of attack of 0°, 4°, and 12°. The variation of section moment coefficient c_m with section normal-force coefficient c_n at six spanwise stations for the vertical tail at 0° angle of attack is presented in figure 8. The variations of normal-force coefficient C_N, and root-bending-moment coefficient C_B with β for the vertical tail with and without horizontal tail at various Mach numbers and angles of attack are presented in figures 9 and 10, respectively. Presented in figures 11 to 28 are typical chordwise pressure distributions obtained at six spanwise stations on the vertical tail with and without the horizontal tail at $\beta = 4^\circ$, 8°, and 12°, at $\alpha = 0^\circ$ and 12°, and at $M = 0.60$, 0.85, and 0.95.

Examination of the spanwise variations of c_n over the vertical tail with and without the horizontal tail for various angles of sideslip and Mach number at angles of attack of 0°, 4°, and 12° (fig. 7) reveals that presence of the horizontal tail slightly increased the absolute values of c_n on the vertical tail at angles of sideslip less than 12° (an increase attributed to the end-plate effect of the horizontal tail as discussed in reference 3). Presence of the horizontal tail did not materially alter the nature of the loading on the vertical tail at any angle of attack or sideslip. At angles of sideslip up to 8° and angles of attack up to 4°, the spanwise loading over the vertical tail with and without the horizontal tail was generally rectangular. Above $\beta = 8^\circ$, at angles of attack of 0° and 4°, and above $\beta = 4^\circ$ at an angle of attack of 12°, there was a relative decrease in loading near the fuselage juncture, a decrease possibly caused by flow separation over the fuselage at high angles.

The end-plate effect of the horizontal tail is again apparent in the slight increase of C_N and C_B for the vertical tail with horizontal tail at angles of sideslip less than $\beta = 12^\circ$, (figs. 9 and 10, respectively).

Langley Aeronautical Laboratory,
National Advisory Committee for Aeronautics,
Langley Field, Va., August 6, 1954.

REFERENCES

1. Queijo, Manuel J., and Riley, Donald R.: Calculated Subsonic Span Loads and Resulting Stability Derivatives of Unswept and 45° Sweptback Tail Surfaces in Sideslip and in Steady Roll. NACA TN 3245, 1954.

2. Riley, Donald R.: Effect of Horizontal-Tail Span and Vertical Location on the Aerodynamic Characteristics of an Unswept Tail Assembly in Sideslip. NACA Rep. 1171, 1954. (Supersedes NACA TN 2907.)

3. Wiley, Harleth G., and Riley, Donald R.: An Experimental and Theoretical Investigation at High Subsonic Speeds of the Effects of Horizontal-Tail Height on the Aerodynamic Characteristics in Sideslip of an Unswept, Untapered Tail Assembly. NACA RM L53J19, 1953.

4. Helfer, Arleigh P.: Electrical Pressure Integrator. NACA TN 2607, 1952.

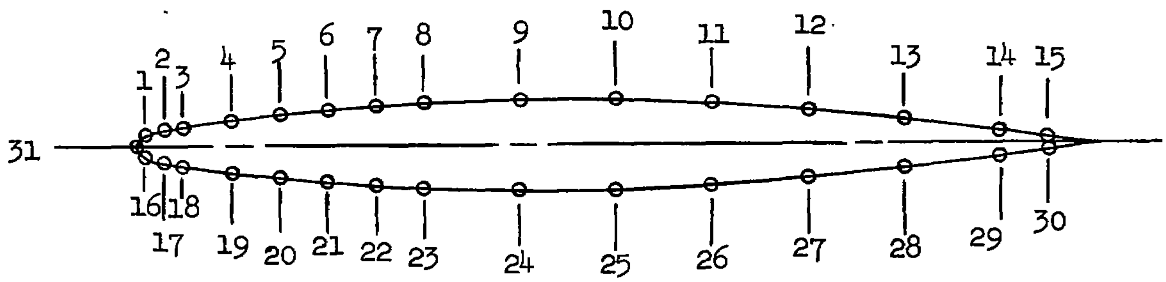
5. Herriot, John G.: Blockage Corrections for Three-Dimensional-Flow Closed-Throat Wind Tunnels, With Consideration of the Effect of Compressibility. NACA Rep. 995, 1950. (Supersedes NACA RM A7B28.)

6. Zender, George W., and Brooks, William A., Jr.: An Approximate Method of Calculating the Deformations of Wings Having Swept, M or W, Λ, and Swept-Tip Plan Forms. NACA TN 2978, 1953.

TABLE I

CHORDWISE PRESSURE-TUBE LOCATIONS AND

CHORDWISE-INTEGRATOR-WEIGHTING FACTORS FOR VERTICAL TAIL



Tube	Chordwise location, percent	Chordwise integrator weightings for	
		c_n	c_m
1 and 16	1	0.2251	0.0961
2 and 17	3	.1750	.0716
3 and 18	5	.3500	.1225
4 and 19	10	.5000	.1364
5 and 20	15	.5000	.0909
6 and 21	20	.5000	.0455
7 and 22	25	.5000	0
8 and 23	30	.7500	-.0852
9 and 24	40	1.0000	-.2727
10 and 25	50	1.0000	-.4545
11 and 26	60	1.0000	-.6364
12 and 27	70	1.0000	-.8182
13 and 28	80	1.0000	-1.0000
14 and 29	90	.6667	-.7550
15 and 30	95	.6667	-.8473
31	0		

TABLE II

SECTION CHARACTERISTICS, STATION $0.931b_v$

(a) $\alpha = 0^{\circ}$.

M	β, deg	Without horizontal tail c_n	Without horizontal tail c_m	With horizontal tail c_n	With horizontal tail c_m
.60	-2	.0609	.011	.0583	.009
.60	0	-.0060	.004	-.0155	.001
.60	2	-.0681	-.003	-.0833	-.006
.60	4	-.1397	-.011	-.1571	-.013
.60	6	-.1958	-.012	-.2142	-.012
.60	8	-.2268	.004	-.2368	.002
.60	12	-.2662	.021	-.2856	.019
.60	16	-.3235	.028	-.3284	.024
.60	20	-.3594	.033	-.4093	.038
.60	23	-.4250	.046	-.4486	.045
.80	-2	.0595	.013	.0578	.010
.80	0	-.0137	.006	-.0177	.001
.80	2	-.0836	-.003	-.0915	-.008
.80	4	-.1544	-.011	-.1645	-.017
.80	6	-.2187	-.013	-.2519	-.012
.80	8	-.2613	.009	-.2728	.009
.80	12	-.2918	.019	-.2920	.019
.80	16	-.2958	.020	-.3057	.035
.80	20	-.3738	.029	-.4052	-.000
.80	23	-.4558	.040	-.4782	.046
.85	-2	.0675	.011	.0576	.010
.85	0	-.0082	.003	-.0179	.001
.85	2	-.0795	-.007	-.0934	-.009
.85	4	-.1499	-.017	-.1697	-.018
.85	6	-.2286	-.014	-.2781	-.012
.85	8	-.2654	.007	-.2841	.017
.85	12	-.2953	.016	-.2945	.016
.85	16	-.2916	.018	-.3147	.021
.85	20	-.3830	.027	-.4284	.038
.85	23	-.4737	.042	-.5151	.054
.90	-2	.0691	.013	.0612	.013
.90	0	-.0014	.003	-.0190	.002
.90	2	-.0818	-.008	-.0964	-.009
.90	4	-.1515	-.019	-.1794	-.021
.90	6	-.2467	-.029	-.3025	-.025
.90	8	-.3687	.002	-.4052	.016
.90	12	-.2805	.014	-.2990	.012
.90	16	-.3003	.017	-.3292	.018
.90	20	-.4131	.027	-.4643	.035
.95	-2	.0742	.013	.0735	.015
.95	0	-.0047	.002	-.0114	.002
.95	2	-.0863	-.009	-.0969	-.011
.95	4	-.1598	-.025	-.1757	-.029
.95	6	-.2561	-.035	-.2853	-.034
.95	8	-.4166	.003	-.4730	.013
.95	12	-.2708	.019	-.2893	.015
.95	16	-.3270	.011	-.3815	.017

TABLE II - Continued

SECTION CHARACTERISTICS, STATION $0.931b_v$

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

M	β, deg	Without horizontal tail c_n	Without horizontal tail c_m	With horizontal tail c_n	With horizontal tail c_m
.60	-2	.0549	.010	.0489	.011
.60	0	.0024	.002	-.0179	.002
.60	2	-.0489	-.007	-.0704	-.007
.60	4	-.1134	-.016	-.1336	-.015
.60	6	-.1695	-.012	-.1968	-.005
.60	8	-.2590	.020	-.2660	.020
.60	12	-.3628	.047	-.3328	.040
.60	16	-.3425	.040	-.3375	.035
.60	20	-.3628	.037	-.3769	.037
.60	23	-.4058	.041	-.4222	.042
.80	-2	.0539	.012	.0498	.012
.80	0	-.0056	.003	-.0161	.002
.80	2	-.0595	-.008	-.0723	-.008
.80	4	-.1230	-.018	-.1365	-.018
.80	6	-.1850	-.018	-.2176	-.011
.80	8	-.2782	.026	-.3131	.034
.80	12	-.3273	.038	-.3404	.029
.80	16	-.3201	.033	-.3075	.029
.80	20	-.3522	.031	-.3830	.031
.80	23	-.4318	.037	-.4616	.039
.85	-2	.0517	.012	.0539	.012
.85	0	-.0030	.003	-.0142	.002
.85	2	-.0622	-.009	-.0741	-.009
.85	4	-.1229	-.018	-.1399	-.019
.85	6	-.2060	-.022	-.2341	-.016
.85	8	-.3131	.025	-.3411	.040
.85	12	-.3176	.031	-.3209	.026
.85	16	-.3251	.029	-.3232	.030
.85	20	-.3551	.028	-.3957	.030
.85	23	-.4472	.036	-.4675	.030
.90	-2	.0564	.014	.0528	.014
.90	0	-.0014	.003	-.0169	.002
.90	2	-.0578	-.009	-.0711	-.009
.90	4	-.1304	-.021	-.1414	-.020
.90	6	-.2325	-.018	-.2413	-.036
.90	8	-.3530	.043	-.3581	-.005
.90	12	-.3164	.028	-.3046	.026
.90	16	-.3418	.025	-.3398	.025
.90	20	-.3657	.025	-.4052	.027
.95	-2	.0582	.014	.0501	.015
.95	0	-.0013	.002	-.0087	.002
.95	2	-.0629	-.009	-.0661	-.010
.95	4	-.1297	-.022	-.1448	-.032
.95	6	-.2006	-.034	-.2523	-.044
.95	8	-.3384	-.004	-.3764	-.017
.95	12	-.3096	.026	-.3484	.025
.95	16	-.3678	.019	-.3891	.025

TABLE II - Concluded

SECTION CHARACTERISTICS, STATION $0.931b_v$

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

M	β, deg	Without horizontal tail c_n	Without horizontal tail c_m	With horizontal tail c_n	With horizontal tail c_m
.60	-2	.0561	.00	.0586	.009
.60	0	-.0215	.01	-.0012	.002
.60	2	-.0478	-.00	-.0598	-.006
.60	4	-.0967	-.01	-.1196	-.014
.60	6	-.1755	-.00	-.2200	-.006
.60	8	-.3271	.03	-.3540	.040
.60	12	-.4943	.08	-.4700	.071
.60	15	-.4035	.05	-.4305	.065
.80	-2	.0555	.00	.0596	.011
.80	0	.0024	.00	-.0032	.003
.80	2	-.0538	-.00	-.0620	-.006
.80	4	-.1085	-.01	-.1264	-.016
.80	6	-.2049	-.00	-.2383	-.005
.80	8	-.3536	.03	-.3679	.033
.80	12	-.4444	.07	-.4291	.058
.80	15	-.3568	.04	-.4154	.044
.85	-2	.0554	.00	.0578	.011
.85	0	-.0022	.00	-.0045	.002
.85	2	-.0592	-.00	-.0615	-.006
.85	4	-.1146	-.01	-.1343	-.018
.85	6	-.2104	-.00	-.2363	-.020
.85	8	-.3579	.03	-.3503	.017
.85	12	-.4119	.05	-.4065	.051
.85	15	-.3969	.05	-.4005	.041
.90	-2	.0521	.01	.0585	.011
.90	0	-.0014	.00	-.0035	.002
.90	2	-.0585	-.00	-.0635	-.008
.90	4	-.1127	-.01	-.1213	-.021
.90	6	-.2099	-.01	-.1897	-.038
.90	8	-.3593	.03	-.3132	-.002
.90	12	-.4057	.05	-.4112	.048
.90	15	-.3811	.04	-.3865	.040
.95	-2	.0595	.01	.0555	.015
.95	0	-.0027	.00	-.0007	.002
.95	2	-.0615	-.00	-.0649	-.011
.95	4	-.1196	-.01	-.1285	-.022
.95	6	-.2211	-.01	-.2155	-.032
.95	8	-.3501	.02	-.3125	-.037
.95	12	-.3574	.04		
.95	15	-.3848	.03		

TABLE III

SECTION CHARACTERISTICS, STATION $0.850b_v$

(a) $\alpha = 0^{\circ}$.

M	β, deg	Without horizontal tail c_n	Without horizontal tail c_m	With horizontal tail c_n	With horizontal tail c_m
.60	-2	.0858	.010	.0901	.007
.60	0	-.0086	.006	.0012	.001
.60	2	-.0983	.002	-.0913	-.007
.60	4	-.1894	.000	-.1827	-.015
.60	6	-.2423	-.004	-.2560	-.016
.60	8	-.3765	.034	-.3966	.030
.60	12	-.4350	.055	-.4159	.042
.60	16	-.4480	.054	-.4315	.040
.60	20	-.4786	.057	-.4904	.046
.60	23	-.5150	.065	-.5373	.052
.80	-2	.0880	.011	.0947	.009
.80	0	-.0058	.004	-.0016	.001
.80	2	-.0956	.000	-.0995	-.009
.80	4	-.1906	-.009	-.1869	-.019
.80	6	-.2691	-.014	-.2735	-.024
.80	8	-.3836	.009	-.4401	.039
.80	12	-.4172	.044	-.4336	.034
.80	16	-.3982	.036	-.3924	.029
.80	20	-.4751	.045	-.5016	.046
.80	23	-.5632	.058	-.5906	.060
.85	-2	.0878	.007	.1011	.009
.85	0	-.0064	.002	.0038	.002
.85	2	-.1036	-.006	-.0981	-.009
.85	4	-.1945	-.015	-.1939	-.021
.85	6	-.2826	-.021	-.2821	-.035
.85	8	-.4005	.025	-.4307	.030
.85	12	-.4161	.033	-.3998	.032
.85	16	-.4139	.031	-.4006	.029
.85	20	-.5099	.042	-.5273	.047
.85	23	-.5999	.058	-.6231	.064
.90	-2	.0914	.010	.1029	.011
.90	0	-.0074	.002	.0000	.002
.90	2	-.1044	-.010	-.0943	-.010
.90	4	-.1944	-.022	-.1965	-.025
.90	6	-.2904	-.035	-.3050	-.044
.90	8	-.4180	-.034	-.4668	-.025
.90	12	-.3981	.027	-.4001	.033
.90	16	-.4319	.025	-.4136	.029
.90	20	-.5269	.041	-.5448	.046
.95	-2	.0883	.012	.1050	.014
.95	0	-.0041	.000	.0061	.000
.95	2	-.0988	-.010	-.1050	-.014
.95	4	-.1928	-.027	-.1986	-.033
.95	6	-.3073	-.046	-.3110	-.049
.95	8	-.4646	-.021	-.5009	-.019
.95	12	-.4267	.037	-.4874	.022
.95	16	-.4557	.026	-.4915	.041

TABLE III - Continued

SECTION CHARACTERISTICS, STATION $0.850b_v$

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

M	β, deg	Without horizontal tail c_n	Without horizontal tail c_m	With horizontal tail c_n	With horizontal tail c_m
.60	-2	.0681	.008	.0720	.007
.60	0	.0060	.002	-.0024	.000
.60	2	-.0765	-.006	-.0756	-.008
.60	4	-.1625	-.015	-.1741	-.016
.60	6	-.2330	-.012	-.2473	-.008
.60	8	-.4147	.026	-.4431	.040
.60	12	-.5390	.071	-.5127	.062
.60	16	-.5115	.065	-.4779	.058
.60	20	-.5103	.059	-.5127	.055
.60	23	-.5402	.062	-.5463	.057
.80	-2	.0789	.009	.0825	.009
.80	0	.0056	.002	-.0105	.000
.80	2	-.0845	-.008	-.0963	-.009
.80	4	-.1699	-.019	-.1845	-.019
.80	6	-.2512	-.026	-.2629	-.019
.80	8	-.4597	.047	-.4798	.047
.80	12	-.5031	.059	-.4668	.045
.80	16	-.4774	.052	-.4717	.045
.80	20	-.4910	.051	-.5065	.046
.80	23	-.5442	.053	-.5882	.057
.85	-2	.0803	.009	.0899	.010
.85	0	.0038	.001	-.0105	.001
.85	2	-.0848	-.009	-.1036	-.011
.85	4	-.1621	-.019	-.2032	-.024
.85	6	-.2522	-.030	-.3125	-.027
.85	8	-.4451	.028	-.5246	.034
.85	12	-.4639	.048	-.4728	.049
.85	16	-.4856	.046	-.5214	.045
.85	20	-.4901	.046	-.5570	.048
.85	23	-.5689	.053	-.6525	.063
.90	-2	.0798	.009	.0898	.011
.90	0	-.0014	.001	-.0106	.001
.90	2	-.0897	-.011	-.1079	-.012
.90	4	-.1667	-.021	-.2030	-.028
.90	6	-.2606	-.028	-.3011	-.047
.90	8	-.4782	.040	-.4558	-.041
.90	12	-.4428	.046	-.4716	.047
.90	16	-.4767	.040	-.5064	.039
.90	20	-.5036	.043	-.5667	.048
.95	-2	.0744	.011	.0822	.013
.95	0	.0000	.000	-.0027	.000
.95	2	-.0865	-.011	-.0956	-.014
.95	4	-.1750	-.026	-.1872	-.034
.95	6	-.2540	-.041	-.3037	-.047
.95	8	-.4008	-.020	-.4176	-.039
.95	12	-.4538	.046	-.5381	.040
.95	16	-.4840	.036	-.5206	.048

TABLE III - Concluded

SECTION CHARACTERISTICS, STATION 0.850b_v

(c) $\alpha = 12^o$.

M	β, deg	Without horizontal tail c_n	Without horizontal tail c_m	With horizontal tail c_n	With horizontal tail c_m
.60	-2	.0801	.006	.0889	.006
.60	0	.0072	.000	.0072	.000
.60	2	-.0658	-.005	-.0781	-.006
.60	4	-.1363	-.011	-.1586	-.014
.60	6	-.2380	-.012	-.2715	-.005
.60	8	-.3815	.017	-.4434	.026
.60	12	-.6290	.087	-.6296	.090
.60	15	-.6015	.095	-.5972	.088
.80	-2	.0814	.008	.0891	.008
.80	0	.0072	.001	-.0032	.000
.80	2	-.0693	-.006	-.0818	-.007
.80	4	-.1434	-.014	-.1692	-.016
.80	6	-.2642	-.011	-.2704	-.013
.80	8	-.4060	.021	-.4396	.013
.80	12	-.5751	.081	-.5562	.073
.80	15	.0000	-.003	-.5416	.060
.85	-2	.0796	.008	.0876	.008
.85	0	.0113	.001	.0121	.002
.85	2	-.0721	-.006	-.0657	-.006
.85	4	-.1412	-.014	-.1661	-.017
.85	6	-.2584	-.011	-.2748	-.027
.85	8	-.4063	.021	-.4076	-.004
.85	12	-.5198	.075	-.5284	.068
.85	15	-.5475	.070	-.5231	.061
.90	-2	.0812	.009	.0859	.009
.90	0	.0078	.000	.0071	.001
.90	2	-.0713	-.007	-.0795	-.008
.90	4	-.1469	-.015	-.1633	-.022
.90	6	-.2606	-.012	-.2386	-.035
.90	8	-.4104	.017	-.3955	-.018
.90	12	-.4937	.073	-.5745	.064
.90	15	-.5191	.131	-.5255	.063
.95	-2	.0804	.010	.0943	.009
.95	0	.0087	.001	.0101	-.000
.95	0	.0087	.001	-.0707	-.011
.95	2	-.0737	-.008	-.1765	-.013
.95	4	-.1528	-.018	-.2951	-.017
.95	6	-.2614	-.021	-.3961	-.020
.95	8	-.4029	.006	-.6387	.066
.95	12	-.4585	.066		
.95	15	-.5161	.127		

TABLE IV

SECTION CHARACTERISTICS, STATION 0.700b_v

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

M	β, deg	Without horizontal tail c_n	Without horizontal tail c_m	With horizontal tail c_n	With horizontal tail c_m
.60	-2	.1100	.004	.1057	.003
.60	0	.0155	.002	.0000	-.000
.60	2	-.0957	-.003	-.1057	-.004
.60	4	-.1985	-.008	-.2173	-.010
.60	6	-.2918	-.006	-.3074	-.005
.60	8	-.3743	.014	-.4239	.020
.60	12	-.7307	.104	-.7120	.096
.60	16	-.7223	.099	-.6892	.087
.60	20	-.7223	.093	-.6472	.073
.60	23	-.7187	.093	-.7552	.084
.80	-2	.1152	.004	.1084	.003
.80	0	.0121	.001	-.0097	-.001
.80	2	-.0999	-.004	-.1286	-.006
.80	4	-.2102	-.011	-.2387	-.013
.80	6	-.3125	-.013	-.3333	-.006
.80	8	-.4253	.018	-.4992	.025
.80	12	-.6839	.094	-.6400	.075
.80	16	-.6460	.077	-.6133	.064
.80	20	-.6549	.071	-.6828	.074
.80	23	-.7564	.086	-.7735	.092
.85	-2	.1163	.004	.1018	.002
.85	0	.0135	.000	-.0121	-.002
.85	2	-.1065	-.005	-.1251	-.007
.85	4	-.2205	-.014	-.2405	-.014
.85	6	-.3360	-.018	-.3498	-.027
.85	8	-.4981	.020	-.6099	.034
.85	12	-.6518	.088	-.6453	.072
.85	16	-.6616	.073	-.6189	.135
.85	20	-.6773	.073	-.7003	.076
.85	23	-.7861	.093	-.7976	.099
.90	-2	.1101	.003	.1042	.002
.90	0	.0078	.001	-.0121	-.001
.90	2	-.1129	-.006	-.1354	-.008
.90	4	-.2308	-.017	-.2580	-.019
.90	6	-.3494	-.032	-.3729	-.034
.90	8	-.4687	-.036	-.4969	-.036
.90	12	-.6515	.079	-.6784	.067
.90	16	-.6628	.072	-.6501	.132
.90	20	-.7002	.076	-.7351	.084
.95	-2	.1166	.004	.1009	.004
.95	0	.0067	.000	-.0013	-.001
.95	2	-.1166	-.007	-.1426	-.010
.95	4	-.2278	-.018	-.2657	-.021
.95	6	-.3523	-.032	-.3955	-.025
.95	8	-.4823	-.031	-.5273	-.018
.95	12	-.7724	.071	-.7257	.064
.95	16	-.6672	.080	-.7170	.083

TABLE IV - Continued

SECTION CHARACTERISTICS, STATION $0.700b_v$

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

M	β, deg	Without horizontal tail c_n	Without horizontal tail c_m	With horizontal tail c_n	With horizontal tail c_m
.60	-2	.1005	.004	.0972	.002
.60	0	.0084	.000	-.0012	-.000
.60	2	-.0849	-.003	-.0996	-.004
.60	4	-.1842	-.008	-.2028	-.009
.60	6	-.2822	-.002	-.2892	-.003
.60	8	-.4162	.025		
.60	12	-.7797	.111	-.7859	.112
.60	16	-.7905	.116	-.7799	.222
.60	20	-.7618	.109	-.7619	.216
.60	23	-.7893	.116	-.7895	.221
.80	-2	.1015	.004	.0946	.005
.80	0	.0097	.001	-.0032	.001
.80	2	-.0910	-.004	-.1059	-.005
.80	4	-.1876	-.009	-.2126	-.011
.80	6	-.2899	-.008	-.3233	-.003
.80	8	-.4807	.037	-.5076	.020
.80	12	-.7231	.110	-.6926	.097
.80	16	-.7569	.107	-.7088	.083
.80	20	-.7505	.101	-.7129	.083
.80	23	-.7875	.101	-.7872	.100
.85	-2	.1014	.004	.1054	.002
.85	0	.0068	-.000	-.0015	-.000
.85	2	-.0924	-.005	-.1032	-.005
.85	4	-.1975	-.011	-.2124	-.012
.85	6	-.3108	-.008	-.3291	-.017
.85	8	-.4903	.017	-.5046	-.003
.85	12	-.6990	.106	-.7380	.093
.85	16	-.7321	.100	-.6846	.077
.85	20	-.7418	.092	-.7162	.084
.85	23	-.7869	.100	-.7968	.103
.90	-2	.1039	.004	.1049	.004
.90	0	.0092	.000	-.0050	-.000
.90	2	-.0933	-.005	-.1141	-.006
.90	4	-.2006	-.012	-.2239	-.016
.90	6	-.3059	-.018	-.3437	-.030
.90	8	-.5242	.019	-.4762	-.009
.90	12	-.7016	.098	-.7781	.096
.90	16	-.7037	.096	-.6647	.077
.90	20	-.7404	.090	-.7172	.084
.95	-2	.1153	.004	.1015	.003
.95	0	.0074	.000	-.0040	-.001
.95	2	-.0945	-.005	-.1237	-.007
.95	4	-.2192	-.015	-.2346	-.013
.95	6	-.3150	-.027	-.3584	-.008
.95	8	-.4605	-.009	-.4727	-.008
.95	12	-.7789	.104	-.8189	.100
.95	16	-.7595	.100	-.7839	.106

TABLE IV - Concluded

SECTION CHARACTERISTICS, STATION $0.700b_v$

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

M	β, deg	Without horizontal tail c_n	Without horizontal tail c_m	With horizontal tail c_n	With horizontal tail c_m
.60	-2	.0849	.003	.1124	.002
.60	0	.0060	.001	.0096	-.001
.60	2	-.0849	-.002	-.0897	-.003
.60	4	-.1710	-.005	-.1937	-.007
.60	6	-.2679	-.001	-.3038	.001
.60	8	-.4030	.008	-.4760	.016
.60	12	-.6721	.054	-.7618	.074
.60	15	-.7905	.108	-.8730	.125
.80	-2	.0967	.003	.1104	.003
.80	0	.0089	.001	-.0008	-.000
.80	2	-.0806	-.002	-.1023	-.003
.80	4	-.1764	-.005	-.2070	-.008
.80	6	-.2884	.000	-.3375	-.006
.80	8	-.4301	.012	-.4873	-.005
.80	12	-.6501	.067	-.7048	.087
.80	15	-.7588	.116	-.7524	.107
.85	-2	.1014	.003	.1111	.002
.85	0	.0143	.001	.0023	-.000
.85	2	-.0924	-.003	-.1051	-.003
.85	4	-.1751	-.005	-.2072	-.009
.85	6	-.2855	-.002	-.3349	-.018
.85	8	-.4395	.011	-.4760	-.015
.85	12	-.6732	.066	-.7246	.080
.85	15	-.7265	.098	-.7501	.101
.90	-2	.0792	.003	.1137	.007
.90	0	.0035	.001	.0028	.000
.90	2	-.0869	-.002	-.1066	-.006
.90	4	-.1795	-.005	-.2204	-.016
.90	6	-.3032	-.008	-.3348	-.020
.90	8	-.4431	.008	-.4746	-.016
.90	12	-.6792	.078	-.7734	.069
.90	15	-.7181	.106	-.7783	.105
.95	-2	.0946	.004	.1153	-.001
.95	0	.0121	.001	.0007	-.001
.95	2	-.0872	-.001	-.1019	-.004
.95	4	-.1992	-.006	-.2306	.002
.95	6	-.3126	-.010	-.3606	.008
.95	8	-.4508	.000	-.4974	.020
.95	12	-.6828	.060	-.7903	.080
.95	15	-.7526	.116		

TABLE V

SECTION CHARACTERISTICS, STATION $0.450b_v$

(a) $\alpha = 0^{\circ}$.

M	β, deg	Without horizontal tail c_n	Without horizontal tail c_m	With horizontal tail c_n	With horizontal tail c_m
.60	-2	.1147	.003	.1096	.005
.60	0	.0012	.002	-.0048	.003
.60	2	-.1064	-.001	-.1179	.001
.60	4	-.2235	-.004	-.2454	-.002
.60	6	-.3454	-.004	-.3788	-.001
.60	8	-.5139	.002	-.5622	.003
.60	12	-.8330	.029	-.8969	.043
.60	16	-1.1676	.131	-1.2054	.157
.60	20	-1.2023	.182	-1.0482	.147
.60	23	-1.2596	.194	-1.0303	.155
.80	-2	.1183	.002	.1067	.004
.80	0	.0000	.001	-.0088	.003
.80	2	-.1151	-.001	-.1340	.001
.80	4	-.2391	-.005	-.2648	-.002
.80	6	-.3727	-.010	-.4036	-.007
.80	8	-.5337	-.001	-.5656	-.000
.80	12	-.9306	.059	-1.0270	.096
.80	16	-1.0819	.161	-.9884	.137
.80	20	-1.0280	.152	-.9387	.134
.80	23	-1.0465	.164	-.9788	.150
.85	-2	.1208	.002	.1084	.003
.85	0	.0075	.001	-.0090	.003
.85	2	-.1148	-.001	-.1383	.000
.85	4	-.2462	-.004	-.2766	-.003
.85	6	-.3790	-.008	-.4216	-.004
.85	8	-.5517	-.002	-.5906	.003
.85	12	-.9270	.058	-1.0205	.095
.85	16	-1.0516	.157	-.9509	.132
.85	20	-1.0095	.152	-.9270	.134
.85	23	-1.0328	-.006	-.9868	.153
.90	-2	.1285	.002	.1076	.003
.90	0	.0106	.001	-.0105	.003
.90	2	-.1130	-.000	-.1449	.001
.90	4	-.2450	-.003	-.2918	-.001
.90	6	-.3848	-.011	-.4451	-.000
.90	8	-.5366	-.003	-.6224	.020
.90	12	-.9165	.064	-1.0162	.110
.90	16	-1.0640	-.006	-.9473	.137
.90	20	-1.0273	-.006	-.9529	.144
.95	-2	.1340	.001	.1148	.003
.95	0	.0114	.001	-.0133	.004
.95	2	-.1172	-.000	-.1575	.007
.95	4	-.2579	-.001	-.2936	.012
.95	6	-.3992	-.002	-.4403	.016
.95	8	-.5473	.003	-.5831	.023
.95	12	-.9432	.102	-1.0074	.126
.95	16	-1.1488	-.006	-1.0321	-.006

TABLE V - Continued

SECTION CHARACTERISTICS, STATION $0.450b_v$

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

M	β, deg	Without horizontal tail c_n	Without horizontal tail c_m	With horizontal tail c_n	With horizontal tail c_m
.60	- 2	.1076	.003	.1010	.003
.60	0	.0120	.001	- .0048	.002
.60	2	- .0908	-.000	- .1189	.000
.60	4	- .2020	-.003	- .2342	-.002
.60	6	- .3131	-.004	- .3566	-.002
.60	8	- .4673	.000	- .5278	.005
.60	12	- .7780	.011	- .8571	.018
.60	16	-1.0911	.086	-1.1840	.119
.60	20	-1.2680	.168	-1.2410	.183
.60	23	-1.3218	.200	-1.2993	.201
.80	- 2	.1102	.002	.1065	.003
.80	0	.0080	.001	- .0048	.002
.80	2	- .1006	-.000	- .1265	-.000
.80	4	- .2133	-.003	- .2458	-.003
.80	6	- .3340	-.007	- .3723	-.010
.80	8	- .4909	-.003	- .5341	-.002
.80	12	- .7983	.016	- .8560	.021
.80	16	-1.0735	.137	-1.0593	.154
.80	20	-1.1620	-.007	-1.0625	.163
.80	23	-1.1483	-.007	-1.0898	-.007
.85	- 2	.1133	.002	.1067	.002
.85	0	.0158	.001	.0037	.002
.85	2	- .0990	.000	- .1269	-.000
.85	4	- .2153	-.003	- .2590	-.004
.85	6	- .3353	-.008	- .3873	-.008
.85	8	- .4891	-.000	- .5366	-.006
.85	12	- .7988	.019	- .8971	.043
.85	16	-1.0786	.135	-1.0113	.149
.85	20	-1.1086	-.007	-1.0404	-.006
.85	23	-1.0951	-.007	-1.0770	-.007
.90	- 2	.1164	.002	.1102	.002
.90	0	.0120	.001	- .0112	.002
.90	2	- .0987	.000	- .1347	.000
.90	4	- .2243	-.004	- .2604	-.000
.90	6	- .3527	-.005	- .4120	.005
.90	8	- .4994	-.001	- .5685	.016
.90	12	- .8288	.037	- .9215	.075
.90	16	-1.1349	.140	-1.0211	.136
.90	20	-1.0792	-.007	-1.0309	-.006
.95	- 2	.1171	.002	.1066	-.004
.95	0	.0134	.001	- .0306	.001
.95	2	- .1071	.000	- .1405	.009
.95	4	- .2309	-.003	- .2744	.014
.95	6	- .3527	-.003	- .4030	.020
.95	8	- .5086	.011	- .5495	.033
.95	12	- .8398	.061	- .8992	.101
.95	16	-1.1109	.137	-1.1190	-.003

TABLE V - Concluded

SECTION CHARACTERISTICS, STATION 0.450b_v

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

M	β, deg	Without horizontal tail c_n	Without horizontal tail c_m	With horizontal tail c_n	With horizontal tail c_m
.60	-2	.1075	.001	.1214	.001
.60	0	.0119	.001	.0107	.001
.60	2	-.0872	.001	-.1095	.001
.60	4	-.1911	-.001	-.2261	-.001
.60	6	-.2986	-.005	-.3522	-.003
.60	8	-.4240	-.011	-.4867	-.007
.60	12	-.6843	-.001	-.7806	-.006
.60	15	-.9172	.022	-1.0150	.027
.80	-2	.1086	-.000	.1282	.001
.80	0	.0145	.001	.0056	.001
.80	2	-.0885	.001	-.1186	.002
.80	4	-.2010	-.001	-.2525	-.001
.80	6	-.3193	-.006	-.3751	-.006
.80	8	-.4326	-.011	-.5033	-.006
.80	12	-.6795	.004	-.7502	-.002
.80	15	-.9047	.040	-.9626	.037
.85	-2	.1106	-.000	.1292	.002
.85	0	.0075	.000	.0082	.002
.85	2	-.1031	.001	-.1218	.002
.85	4	-.2167	-.001	-.2585	.000
.85	6	-.3339	-.006	-.3780	-.002
.85	8	-.4535	-.011	-.5035	.002
.85	12	-.7165	.004	-.7590	.015
.85	15	-.9107	.038	-.9503	.050
.90	-2	.1110	-.001	.1279	-.006
.90	0	.0028	-.000	.0077	.001
.90	2	-.1103	.001	-.1159	.006
.90	4	-.2276	-.001	-.2438	.010
.90	6	-.3323	-.004	-.3766	.014
.90	8	-.4651	-.009	-.4890	.020
.90	12	-.7215	.010	-.7356	.038
.90	15	-.9182	.047	-.9063	.065
.95	-2	.1139	-.001	.1080	-.008
.95	0	.0127	.000	.0147	-.006
.95	2	-.1099	.001	-.0940	.003
.95	4	-.2251	-.001	-.2174	.015
.95	6	-.3397	-.003	-.3200	.026
.95	8	-.4716	-.002	-.4460	.038
.95	12	-.7327	.023	-.6794	.053
.95	15	-.9172	.066		

TABLE VI

SECTION CHARACTERISTICS, STATION 0.300b_v

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

M	β, deg	Without horizontal tail c_n	Without horizontal tail c_m	With horizontal tail c_n	With horizontal tail c_m
.60	−2	.1000	.000	.0939	−.000
.60	0	−.0119	.000	−.0297	.001
.60	2	−.1261	−.000	−.1498	.000
.60	4	−.2463	−.001	−.2793	−.000
.60	6	−.3713	.002	−.3994	.009
.60	8	−.4795	.012	−.5302	.018
.60	12	−.8103	−.017	−.8416	−.002
.60	16	−1.1530	.014	−1.2529	.048
.60	20	−1.4386	.137	−1.2600	.202
.60	23	−1.4576	.216	−1.1768	.195
.80	−2	.0994	−.000	.0985	−.001
.80	0	−.0160	.000	−.0288	.001
.80	2	−.1330	.001	−.1561	.002
.80	4	−.2589	.000	−.2907	.002
.80	6	−.3939	.003	−.4244	.009
.80	8	−.5138	.012	−.5877	.019
.80	12	−.8175	−.006	−.8584	.012
.80	16	−1.1910	.098	−1.2323	.151
.80	20	−1.1974	−.007	−1.0737	−.007
.80	23	−1.1758	−.008	−1.1050	−.007
.85	−2	−.1024	−.001	.1028	−.001
.85	0	−.0149	.000	−.0276	.001
.85	2	−.1390	.001	−.1535	.003
.85	4	−.2631	.001	−.2973	.005
.85	6	−.3968	.004	−.4478	.012
.85	8	−.5381	.013	−.6095	.025
.85	12	−.8071	.007	−.9068	.033
.85	16	−1.1972	.115	−1.2048	.149
.85	20	−1.1621	−.007	−1.0938	−.007
.85	23	−1.1457	−.008	−1.1132	−.007
.90	−2	.1027	−.002	.1072	−.004
.90	0	−.0141	.000	−.0315	.001
.90	2	−.1392	.003	−.1633	.006
.90	4	−.2778	.004	−.3084	.013
.90	6	−.4388	.007	−.4682	.027
.90	8	−.5654	.016	−.6161	.042
.90	12	−.8615	.036	−.9063	.057
.90	16	−1.1835	.123	−1.1810	.146
.90	20	−1.1814	.149	−1.1334	−.007
.95	−2	.1081	−.005	.0978	−.004
.95	0	−.0133	−.000	−.0293	.004
.95	2	−.1468	.006	−.1610	.013
.95	4	−.2882	.010	−.3061	.023
.95	6	−.4177	.018	−.4465	.034
.95	8	−.5604	.028	−.5969	.048
.95	12	−.8673	.070	−.8956	.075
.95	16	−1.0742	.096	−1.1312	.115

TABLE VI - Continued

SECTION CHARACTERISTICS, STATION 0.300b_v

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

M	β, deg	Without horizontal tail		With horizontal tail	
		c_n	c_m	c_n	c_m
.60	-2	.0903	.001	.0952	.001
.60	0	-.0119	.001	-.0214	.001
.60	2	-.1188	-.000	-.1249	-.000
.60	4	-.2256	-.001	-.2439	-.002
.60	6	-.3384	-.000	-.3569	.002
.60	8	-.4536	.003	-.4853	.006
.60	12	-.7327	-.014	-.7827	-.003
.60	16	-1.0605	.011	-1.0944	.022
.60	20	-1.3847	.087	-1.4227	.121
.60	23	-1.5236	.150	-1.4833	.193
.80	-2	.0920	.001	.0825	.002
.80	0	-.0136	.001	-.0208	.002
.80	2	-.1239	.000	-.1394	.001
.80	4	-.2415	-.001	-.2555	.000
.80	6	-.3638	.001	-.3813	.005
.80	8	-.4838	.004	-.5270	.014
.80	12	-.7685	.004	-.8290	.024
.80	16	-1.1195	.060	-1.1630	.095
.80	20	-1.3122	.161	-1.2896	.169
.80	23	-1.2546	-.008	-1.2647	-.008
.85	-2	.0917	.000	.0956	.001
.85	0	-.0164	.001	-.0202	.002
.85	2	-.1290	.001	-.1381	.003
.85	4	-.2393	.000	-.2606	.004
.85	6	-.3661	.003	-.4032	.011
.85	8	-.4839	.008	-.5555	.024
.85	12	-.7627	.012	-.8362	.046
.85	16	-1.0684	.067	-1.0863	.096
.85	20	-1.2668	-.005	-1.2505	-.006
.85	23	-1.2243	-.008	-1.2356	-.008
.90	-2	.0870	.001	.0927	-.001
.90	0	-.0168	.001	-.0281	.005
.90	2	-.1276	.002	-.1440	.009
.90	4	-.2441	.002	-.2760	.016
.90	6	-.3724	.005	-.4144	.028
.90	8	-.5092	.011	-.5618	.045
.90	12	-.7869	.028	-.8182	.066
.90	16	-1.0275	.064	-1.0113	.082
.90	20	-1.2498	-.007	-1.2325	-.006
.95	-2	.0985	-.001	.0826	-.000
.95	0	-.0087	.001	-.0207	.005
.95	2	-.1284	.004	-.1400	.011
.95	4	-.2482	.005	-.2599	.016
.95	6	-.3853	.012	-.3899	.029
.95	8	-.5203	.023	-.5319	.048
.95	12	-.8025	.049	-.7698	.067
.95	16	-1.0420	.080	-1.0031	.094

TABLE VI - Concluded

SECTION CHARACTERISTICS, STATION 0.300b_v

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

M	β, deg	Without horizontal tail c_n	Without horizontal tail c_m	With horizontal tail c_n	With horizontal tail c_m
.60	-2	.0938	-.002	.1095	-.001
.60	0	-.0214	-.000	-.0119	-.001
.60	2	-.1330	.001	-.1309	-.000
.60	4	-.2469	.002	-.2618	-.000
.60	6	-.3443	.008	-.3713	.002
.60	8	-.4630	.014	-.4974	.005
.60	12	-.7182	.018	-.7615	.012
.60	15	-.9141	.031	-.9519	.022
.80	-2	.0960	-.003	.1082	-.002
.80	0	-.0200	-.000	-.0168	.001
.80	2	-.1367	.003	-.1483	.003
.80	4	-.2631	.005	-.2926	.007
.80	6	-.3702	.012	-.4169	.017
.80	8	-.4878	.021	-.5436	.033
.80	12	-.7373	.035	-.7737	.061
.80	15	-.9156	.053	-.9325	.078
.85	-2	.0954	-.005	.1248	-.011
.85	0	-.0201	-.000	-.0112	-.001
.85	2	-.1378	.003	-.1532	.009
.85	4	-.2682	.006	-.3026	.019
.85	6	-.3800	.014	-.4243	.035
.85	8	-.5029	.026	-.5454	.057
.85	12	-.7481	.044	-.7546	.081
.85	15	-.9150	.060	-.9189	.103
.90	-2	.1030	-.006	.1019	-.016
.90	0	-.0210	-.000	-.0155	-.003
.90	2	-.1409	.004	-.1391	.010
.90	4	-.2769	.008	-.2761	.027
.90	6	-.3967	.018	-.3948	.047
.90	8	-.5271	.035	-.5199	.070
.90	12	-.7605	.057	-.7082	.091
.90	15	-.9329	.082	-.8571	.112
.95	-2	.1017	-.007	.0673	-.003
.95	0	-.0219	.000	-.0300	.002
.95	2	-.1476	.007	-.1340	.009
.95	4	-.2899	.012	-.2466	.017
.95	6	-.4176	.026	-.3533	.030
.95	8	-.4907	.050	-.4499	.049
.95	12	-.7627	.075	-.6465	.085

TABLE VII

SECTION CHARACTERISTICS, STATION $0.200b_v$

(a) $\alpha = 0^{\circ}$.

M	β, deg	Without horizontal tail		With horizontal tail	
		c_n	c_m	c_n	c_m
.60	-2	.0915	-.004	.0771	-.005
.60	0	-.0249	.000	-.0202	.000
.60	2	-.1330	.003	-.1157	.004
.60	4	-.2530	.007	-.2170	.009
.60	6	-.3599	.011	-.3221	.014
.60	8	-.5072	.013	-.4330	.016
.60	12	-.6439	.008	-.6519	.019
.60	16	-.7520	.010	-.9180	.037
.60	20	-1.0513	.026	-1.0414	.146
.60	23	-1.3210	.065	-1.0173	.165
.80	-2	.0904	-.005	.0893	-.005
.80	0	-.0184	.000	-.0298	.003
.80	2	-.1377	.005	-.1529	.011
.80	4	-.2609	.011	-.2881	.020
.80	6	-.3938	.016	-.4305	.028
.80	8	-.5235	.020	-.5697	.034
.80	12	-.7764	.030	-.8450	.050
.80	16	-1.0526	.077	-1.1419	.109
.80	20	-1.2295	.170	-1.1685	-.008
.80	23	-1.2311	-.008	-1.1958	-.008
.85	-2	.0948	-.006	.0945	-.006
.85	0	-.0269	.000	-.0330	.005
.85	2	-.1426	.006	-.1628	.014
.85	4	-.2717	.014	-.3023	.026
.85	6	-.4015	.021	-.4486	.038
.85	8	-.5418	.027	-.5926	.048
.85	12	-.7986	.041	-.8776	.073
.85	16	-1.0755	.091	-1.1281	.121
.85	20	-1.2225	-.007	-1.1671	-.008
.85	23	-1.2277	-.008	-1.1919	-.008
.90	-2	.1018	-.009	.0960	-.008
.90	0	-.0197	.000	-.0388	.008
.90	2	-.1439	.008	-.1729	.023
.90	4	-.2737	.018	-.3196	.044
.90	6	-.4225	.029	-.4551	.056
.90	8	-.5474	.039	-.6005	.071
.90	12	-.8134	.064	-.8792	.100
.90	16	-1.0527	.096	-1.0767	.125
.90	20	-1.2324	-.007	-1.1607	-.007
.95	-2	.1014	-.011	.0823	-.003
.95	0	-.0200	.000	-.0415	.014
.95	2	-.1474	.012	-.1694	.030
.95	4	-.2855	.026	-.2979	.042
.95	6	-.4315	.039	-.4425	.057
.95	8	-.5356	.034	-.5797	.071
.95	12	-.8050	.063	-.8495	.104
.95	16	-1.0111	.078	-1.0309	.121

TABLE VII - Continued

SECTION CHARACTERISTICS, STATION 0.200b_v

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

M	β, deg	Without horizontal tail		With horizontal tail	
		c_n	c_m	c_n	c_m
.60	-2	.0822	-.003	.0871	-.005
.60	0	-.0191	-.000	-.0310	.002
.60	2	-.1191	.002	-.1456	.011
.60	4	-.2287	.004	-.2673	.020
.60	6	-.3418	.008	-.3985	.032
.60	8	-.4645	.013	-.5250	.038
.60	12	-.7361	.019	-.7934	.045
.60	16	-.9910	.028	-1.0702	.057
.60	20	-1.2781	.045	-1.3231	.076
.60	23	-1.4222	.104	-1.4269	.145
.80	-2	.0810	-.004	.0699	-.004
.80	0	-.0217	.000	-.0305	.004
.80	2	-.1244	.004	-.1527	.012
.80	4	-.2375	.007	-.2684	.017
.80	6	-.3578	.012	-.4026	.026
.80	8	-.4966	.019	-.5320	.036
.80	12	-.7662	.038	-.8061	.070
.80	16	-1.0237	.068	-1.0415	.108
.80	20	-1.2717	.115	-1.2376	.140
.80	23	-1.3350	-.008	-1.2577	-.008
.85	-2	.0792	-.004	.0810	-.007
.85	0	-.0187	.000	-.0360	.006
.85	2	-.1278	.005	-.1582	.017
.85	4	-.2415	.009	-.2872	.025
.85	6	-.3678	.015	-.4094	.038
.85	8	-.4934	.023	-.5519	.056
.85	12	-.7775	.048	-.8203	.096
.85	16	-1.0175	.072	-1.0408	.122
.85	20	-1.2679	.148	-1.2230	.141
.85	23	-1.3045	-.008	-1.2567	-.008
.90	-2	.0844	-.006	.0731	-.009
.90	0	-.0218	.000	-.0556	.012
.90	2	-.1322	.006	-.1765	.028
.90	4	-.2503	.013	-.2982	.040
.90	6	-.3761	.021	-.4269	.053
.90	8	-.5083	.031	-.5605	.071
.90	12	-.7979	.066	-.8263	.109
.90	16	-1.0242	.091	-.9789	.118
.90	20	-1.2618	-.006	-1.1997	-.007
.95	-2	.0834	-.007	.0589	-.001
.95	0	-.0240	.000	-.0542	.015
.95	2	-.1347	.009	-.1653	.028
.95	4	-.2581	.018	-.2777	.038
.95	6	-.3855	.029	-.4029	.052
.95	8	-.5169	.043	-.5220	.068
.95	12	-.7943	.083	-.7676	.104
.95	16	-1.0271	.119	-.9864	.136

TABLE VII - Concluded

SECTION CHARACTERISTICS, STATION $0.200b_v$

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

M	β, deg	Without horizontal tail c_n	Without horizontal tail c_m	With horizontal tail c_n	With horizontal tail c_m
.60	-2	.0393	-.009	.0429	-.018
.60	0	-.0143	-.000	-.0214	-.002
.60	2	-.0607	.010	-.0774	.016
.60	4	-.1226	.018	-.1477	.030
.60	6	-.2381	.024	-.2668	.036
.60	8	-.3321	.032	-.3812	.049
.60	12	-.6094	.042	-.6920	.076
.60	15	-.8118	.047	-.8957	.080
.80	-2	.0417	-.012	.0482	-.028
.80	0	-.0160	.000	-.0265	-.002
.80	2	-.0658	.014	-.0979	.026
.80	4	-.1195	.024	-.1686	.052
.80	6	-.2246	.032	-.2818	.064
.80	8	-.3312	.040	-.3934	.085
.80	12	-.6168	.074	-.6591	.135
.80	15	-.8325	.080	-.8454	.161
.85	-2	.0448	-.014	.0539	-.036
.85	0	-.0127	-.000	-.0247	-.002
.85	2	-.0665	.014	-.1033	.036
.85	4	-.1211	.028	-.1752	.073
.85	6	-.2317	.035	-.2890	.094
.85	8	-.3393	.046	-.3750	.101
.85	12	-.6121	.085	-.6093	.147
.85	15	-.8273	.101	-.7845	-.006
.90	-2	.0485	-.016	.0239	-.024
.90	0	-.0113	-.001	-.0401	.009
.90	2	-.0703	.016	-.0866	.035
.90	4	-.1231	.032	-.1387	.067
.90	6	-.2321	.040	-.2380	.085
.90	8	-.3481	.055	-.3176	.098
.90	12	-.6174	.103	-.5436	.147
.90	15	-.8094	.126	-.7112	-.007
.95	-2	.0467	-.017	.0247	-.021
.95	0	-.0160	-.000	-.0221	.002
.95	2	-.0787	.019	-.0662	.028
.95	4	-.1314	.040	-.1016	.055
.95	6	-.2395	.052	-.1818	.065
.95	8	-.3603	.073	-.2673	.080
.95	12	-.5991	.118		

[redacted]

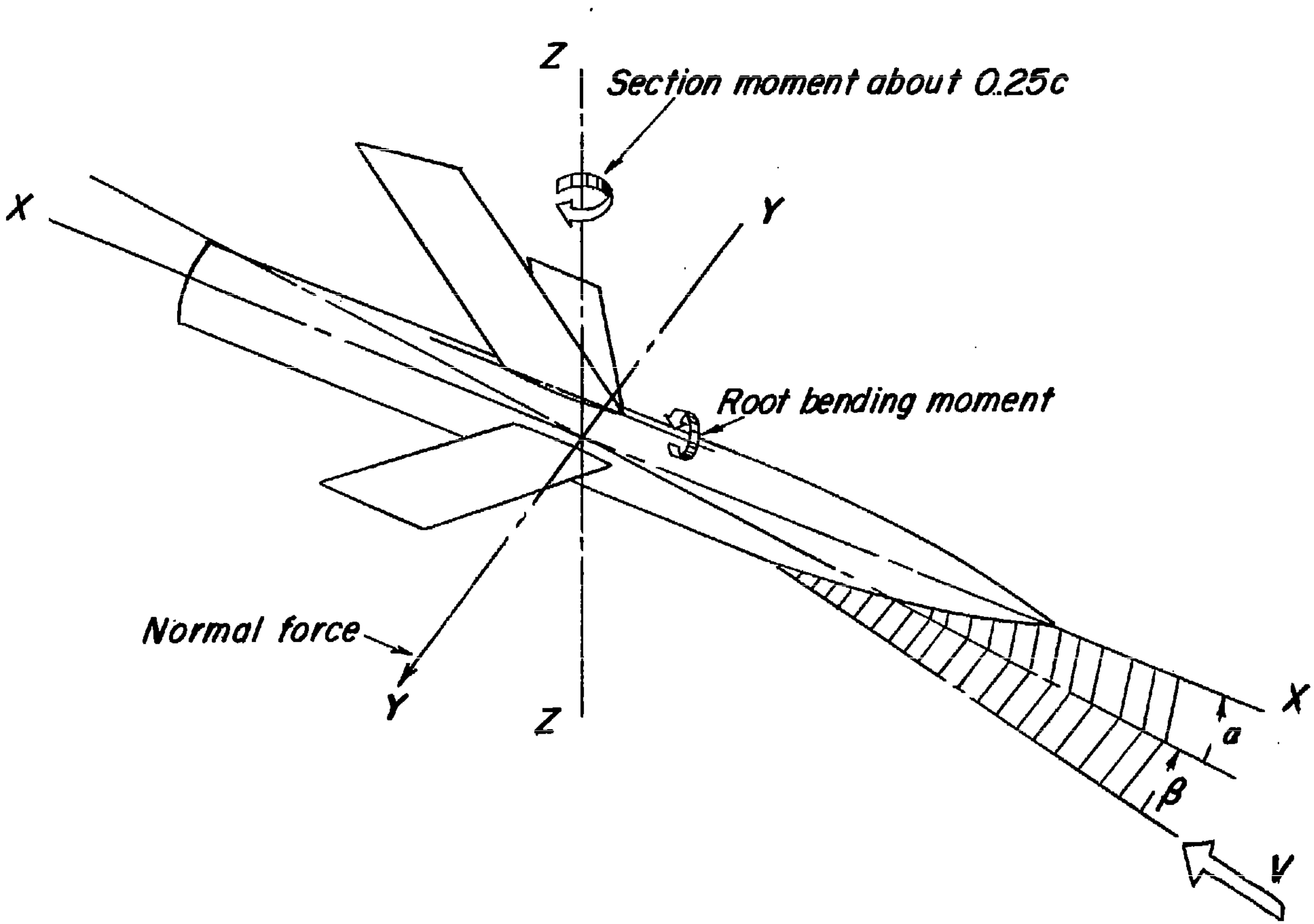


Figure 1.- System of axes used. Positive forces, moments, angles, and velocities are indicated by arrows.

[redacted]

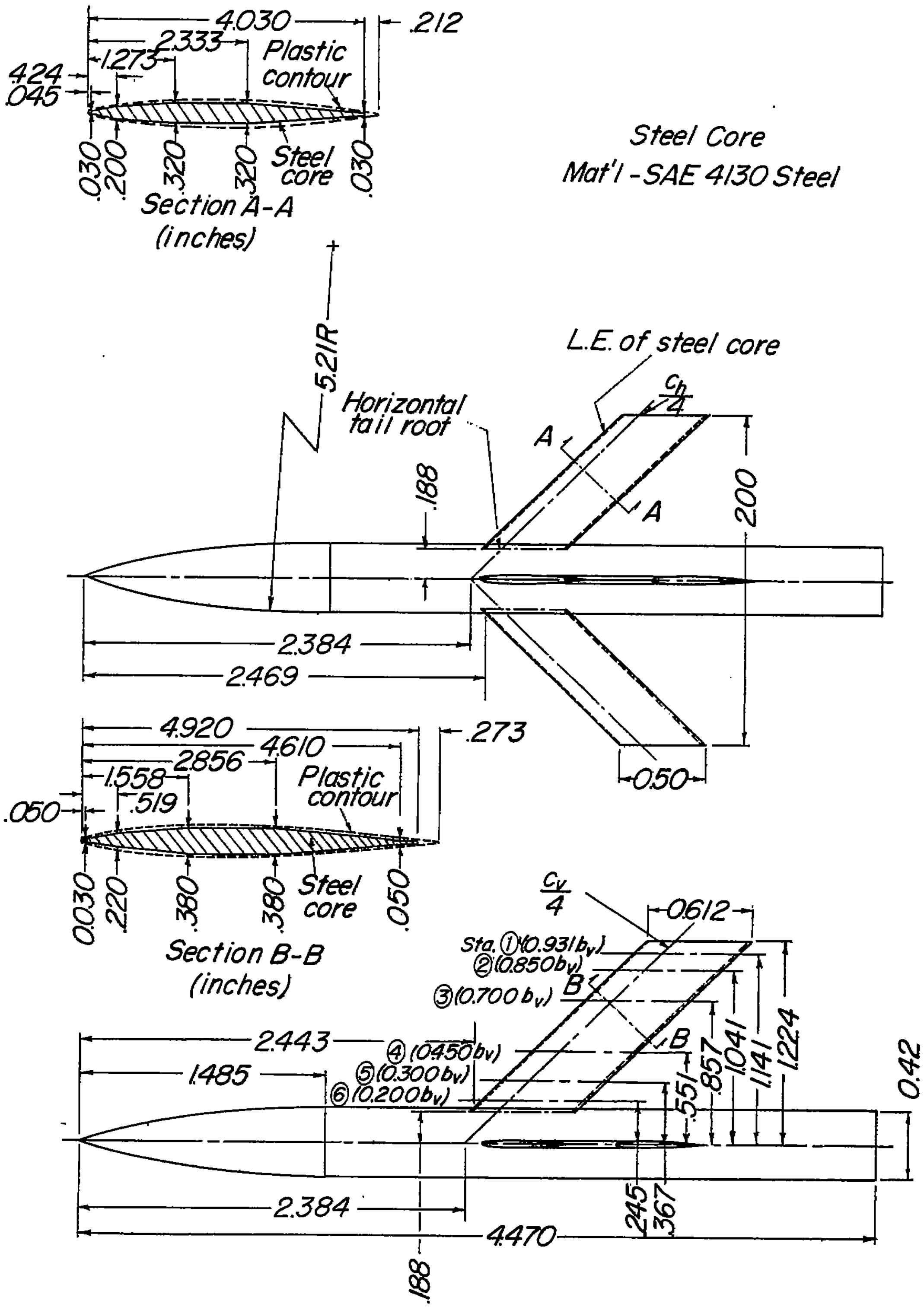


Figure 2.- Physical characteristics of model. (Dimensions in feet unless otherwise noted.)

L-83799

(a) Fuselage and vertical tail.

Figure 3.- Photograph of model mounted on sting support in Langley high-speed 7- by 10-foot tunnel.

L-83800

(b) Fuselage and vertical tail plus horizontal tail.

Figure 3.- Concluded.

[redacted]

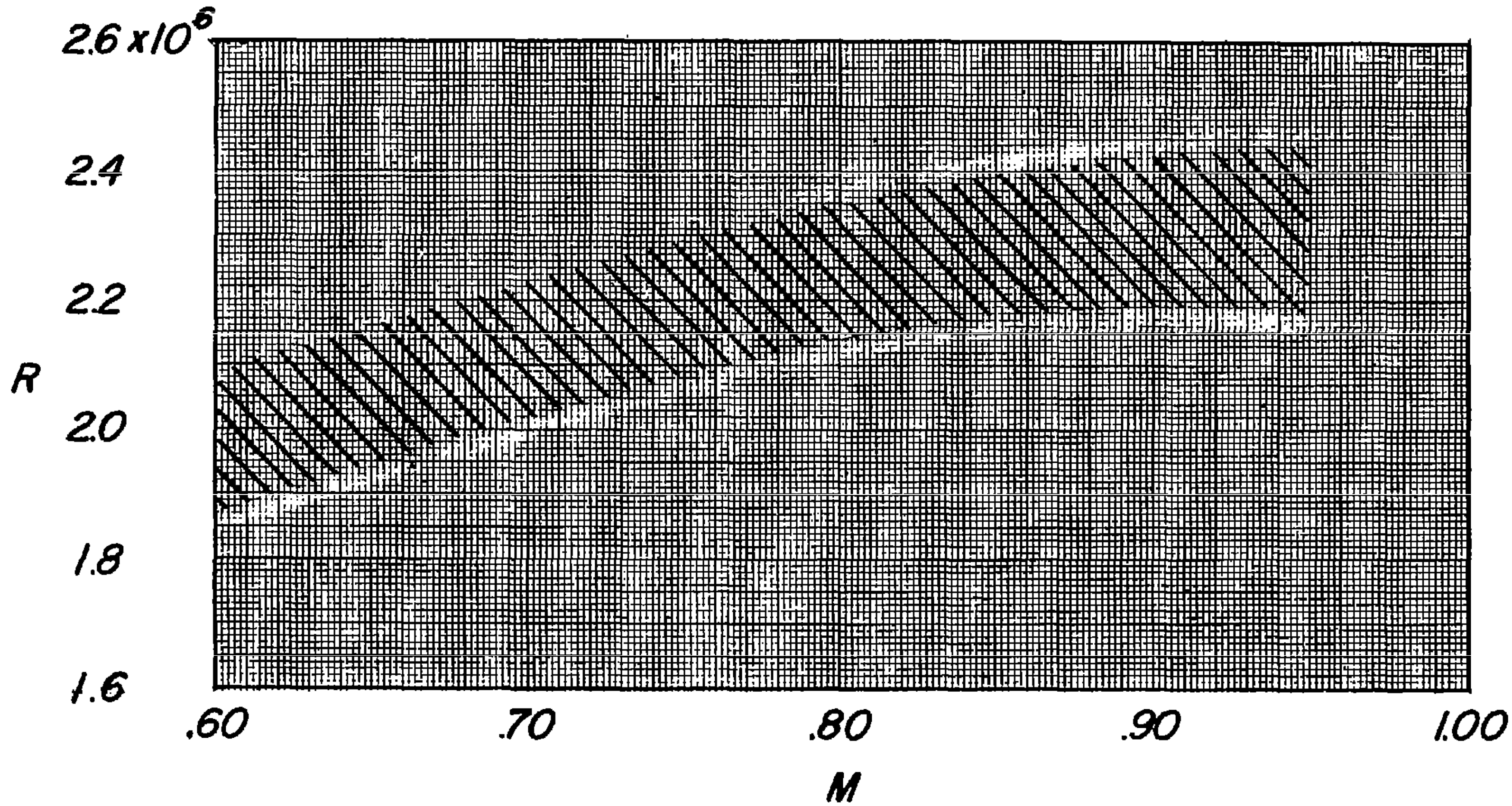
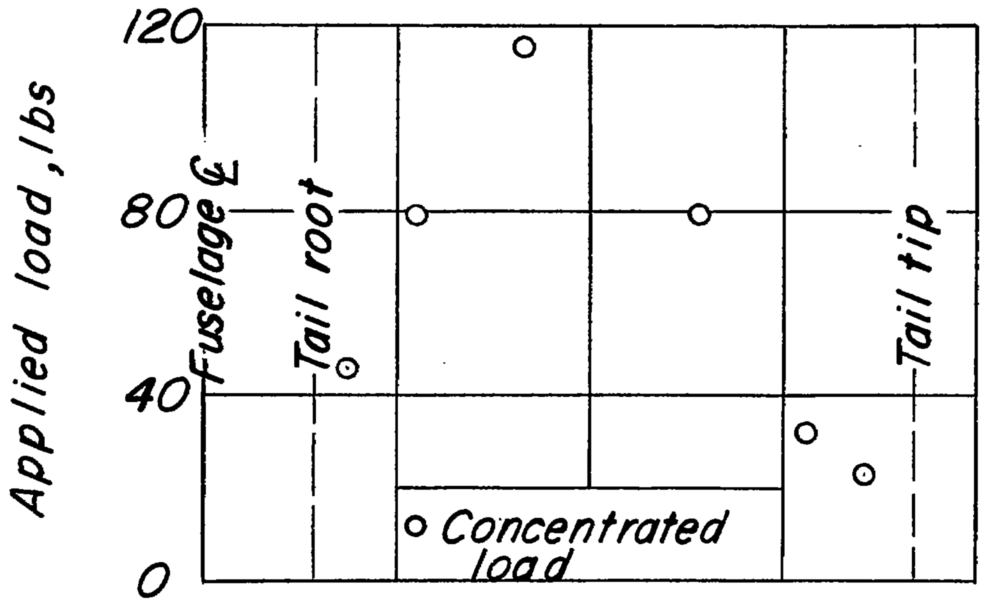
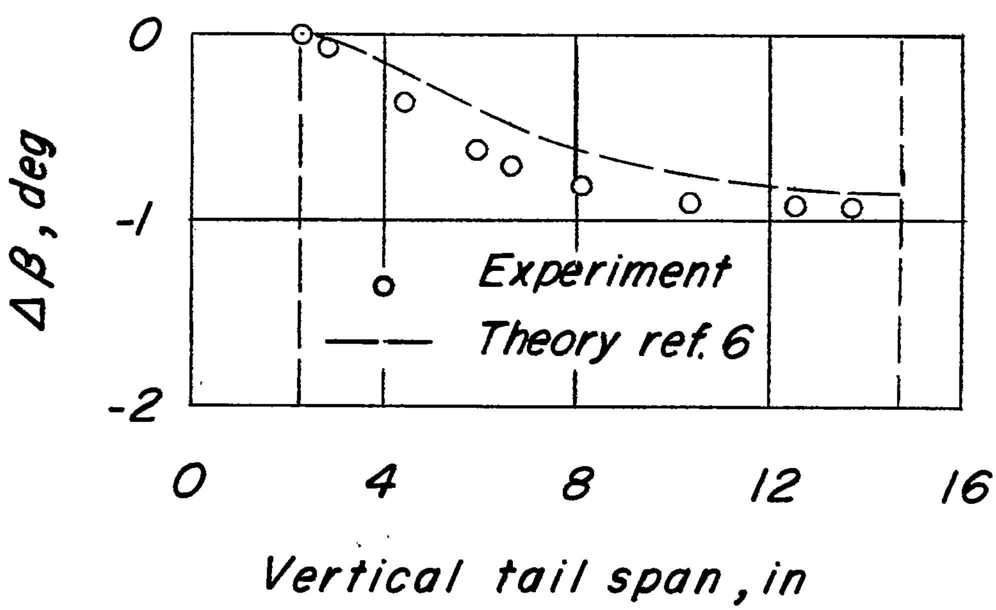


Figure 4.- Variation of test Reynolds number with Mach number. (Reynolds number is based on the mean aerodynamic chord of the vertical tail.)

[redacted]



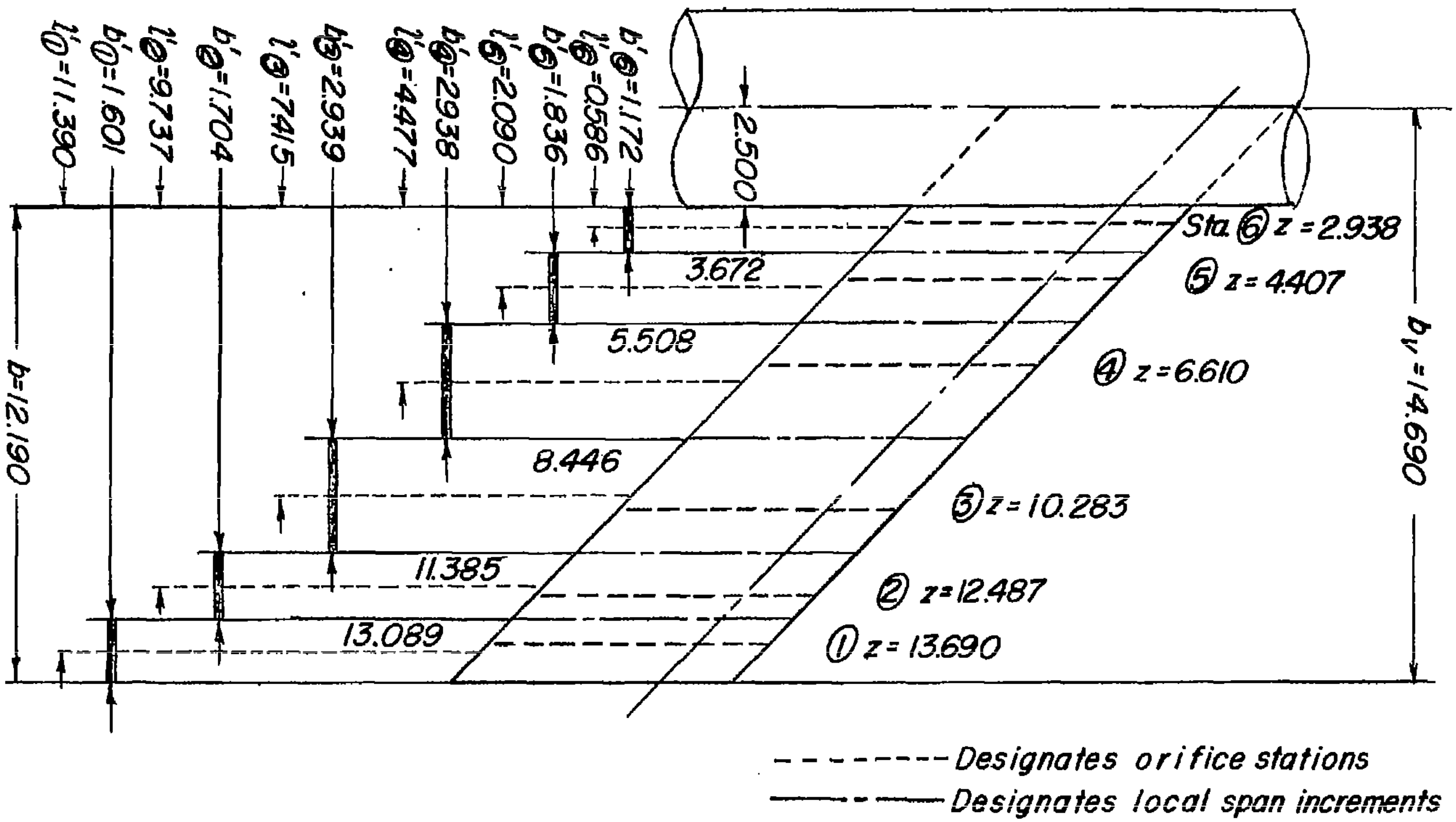
(a) Simulated loading on vertical tail in presence of horizontal tail at $\alpha = 0^{\circ}$, $\beta = 16^{\circ}$, $M = 0.95$, and $q = 746$ lb/sq ft.



(b) Spanwise change in angle of sideslip of vertical tail $\Delta\beta$ due to simulated experimental loading condition.

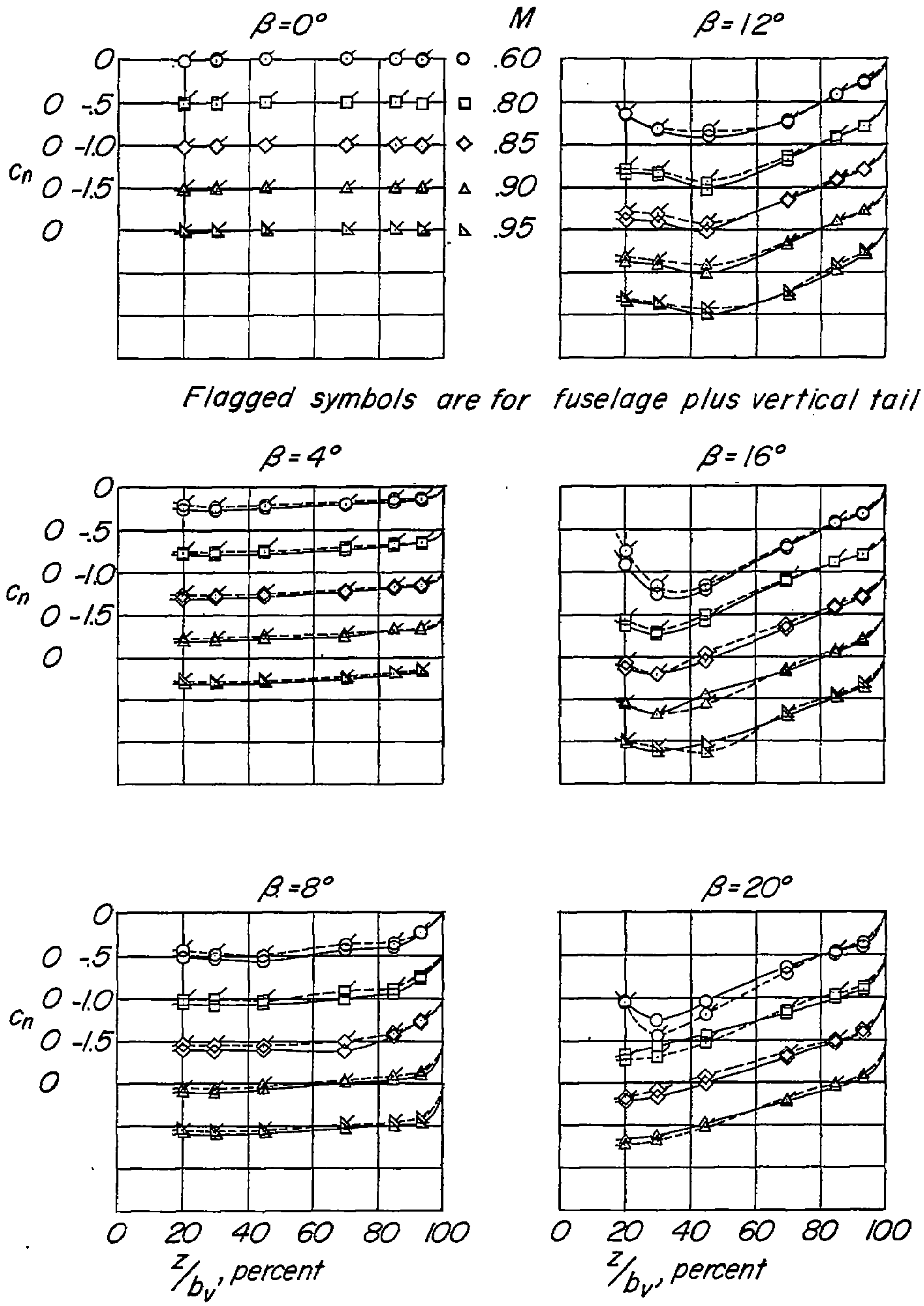
Figure 5.- Spanwise change of angle of sideslip $\Delta\beta$ of vertical tail in presence of horizontal tail for simulated experimental loading condition.

[redacted]



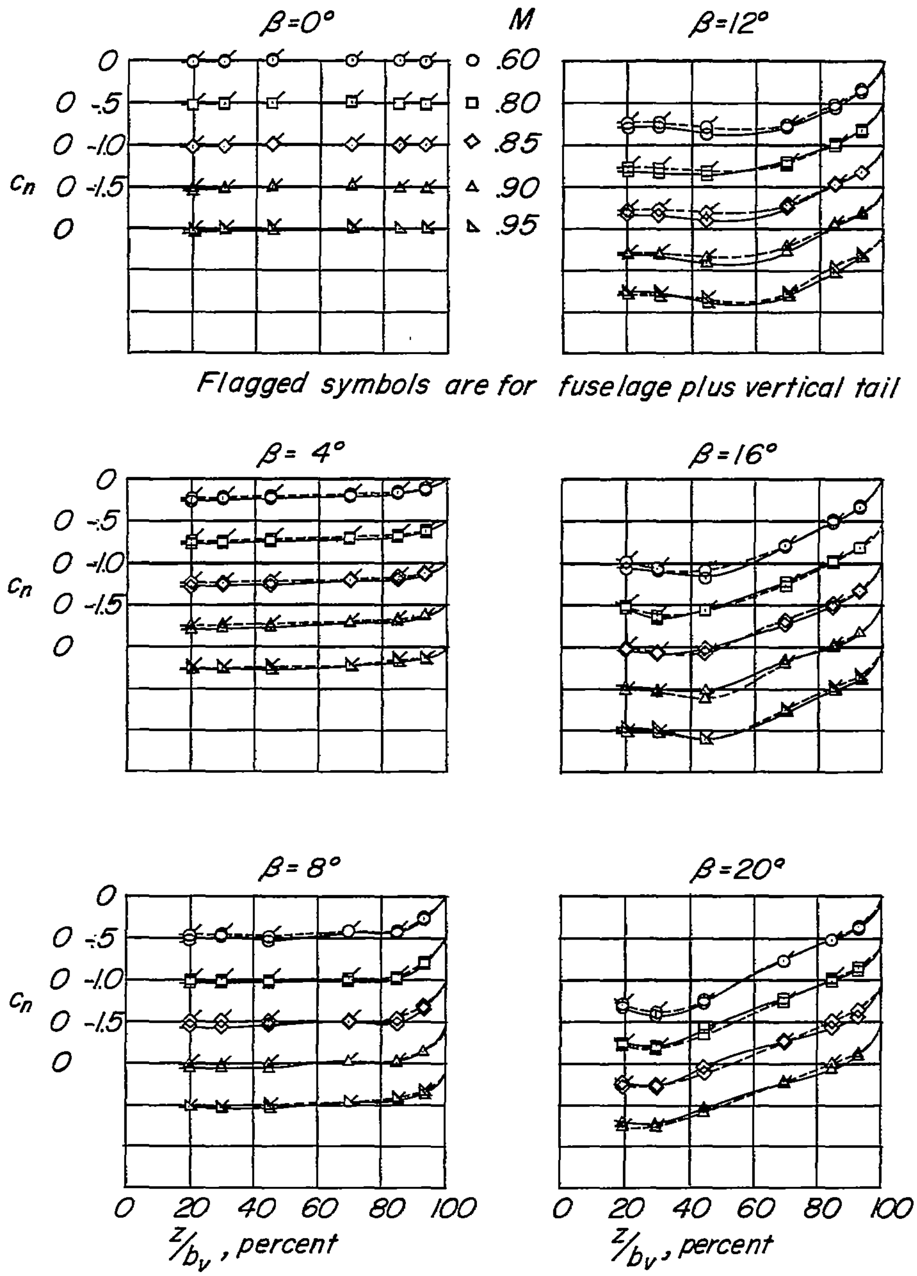
[redacted]

Figure 6.- Details of effective span segments b' and moment arms l for spanwise integrations to obtain C_N and C_B.



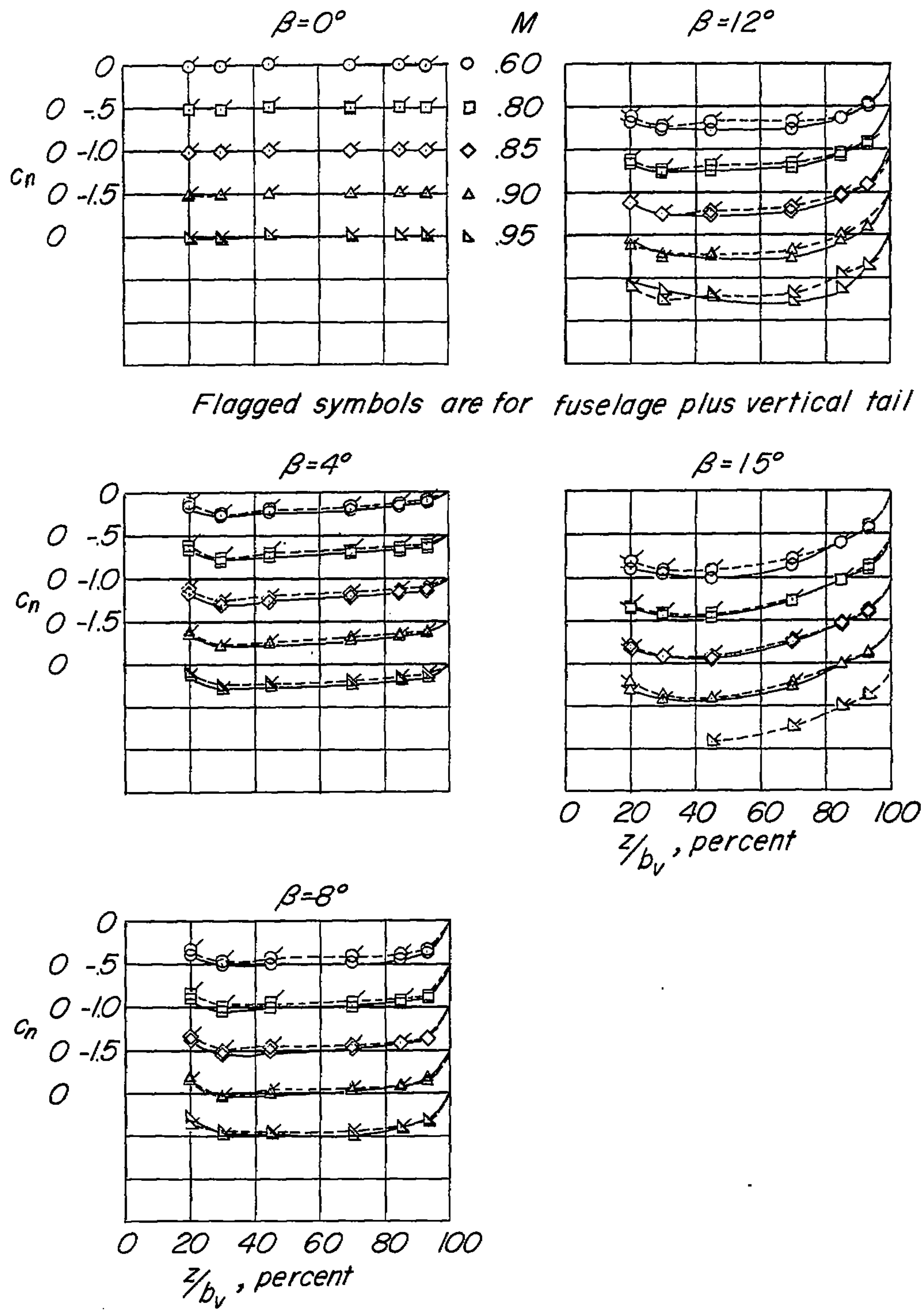
(a) $\alpha = 0^{\circ}$.

Figure 7.- Variation of section normal-force coefficient with spanwise location for various angles of sideslip and Mach numbers. (Symbols without flags are for fuselage plus vertical and horizontal tails.)



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

Figure 7.- Continued.



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

Figure 7.- Concluded.

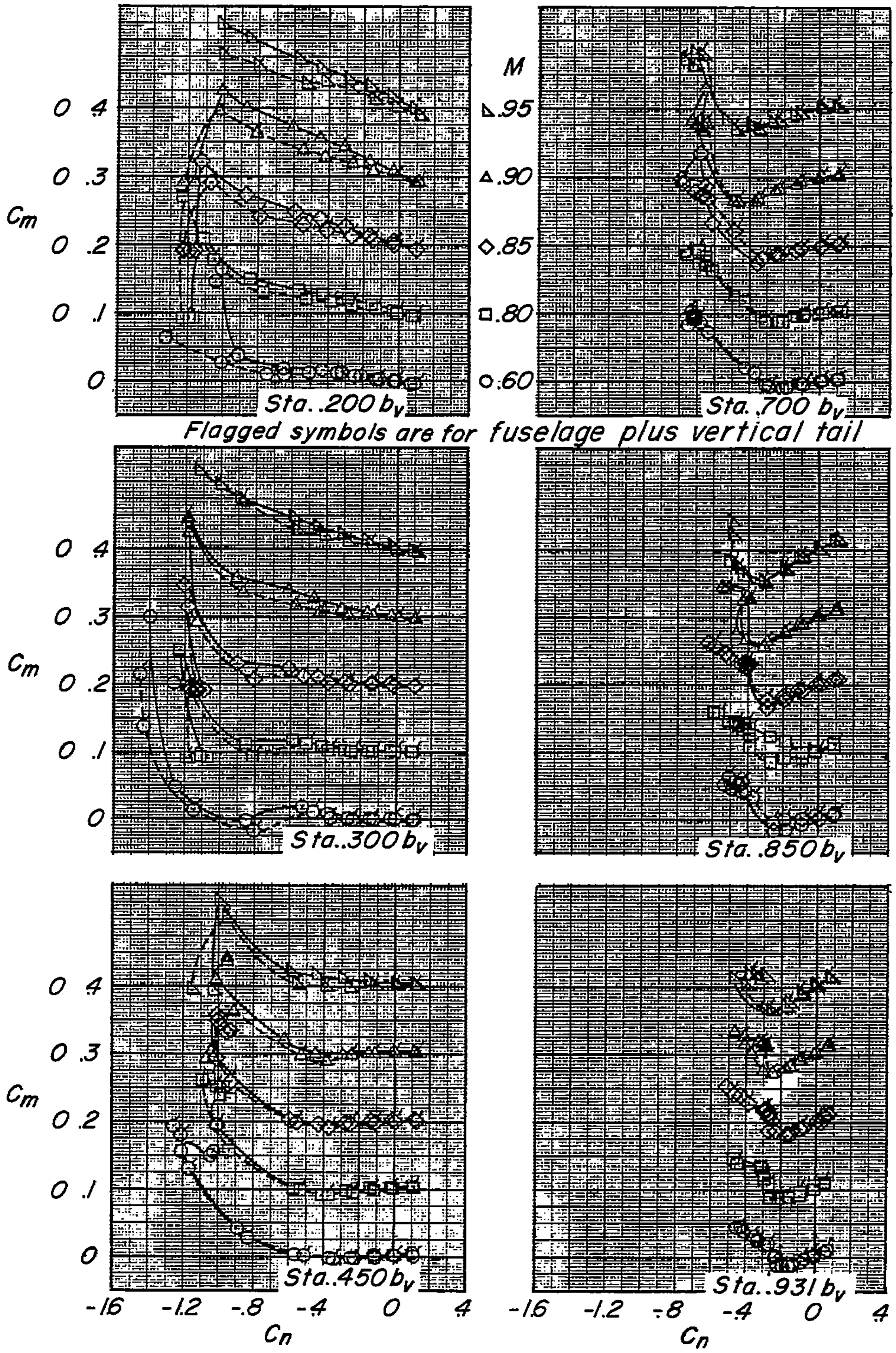
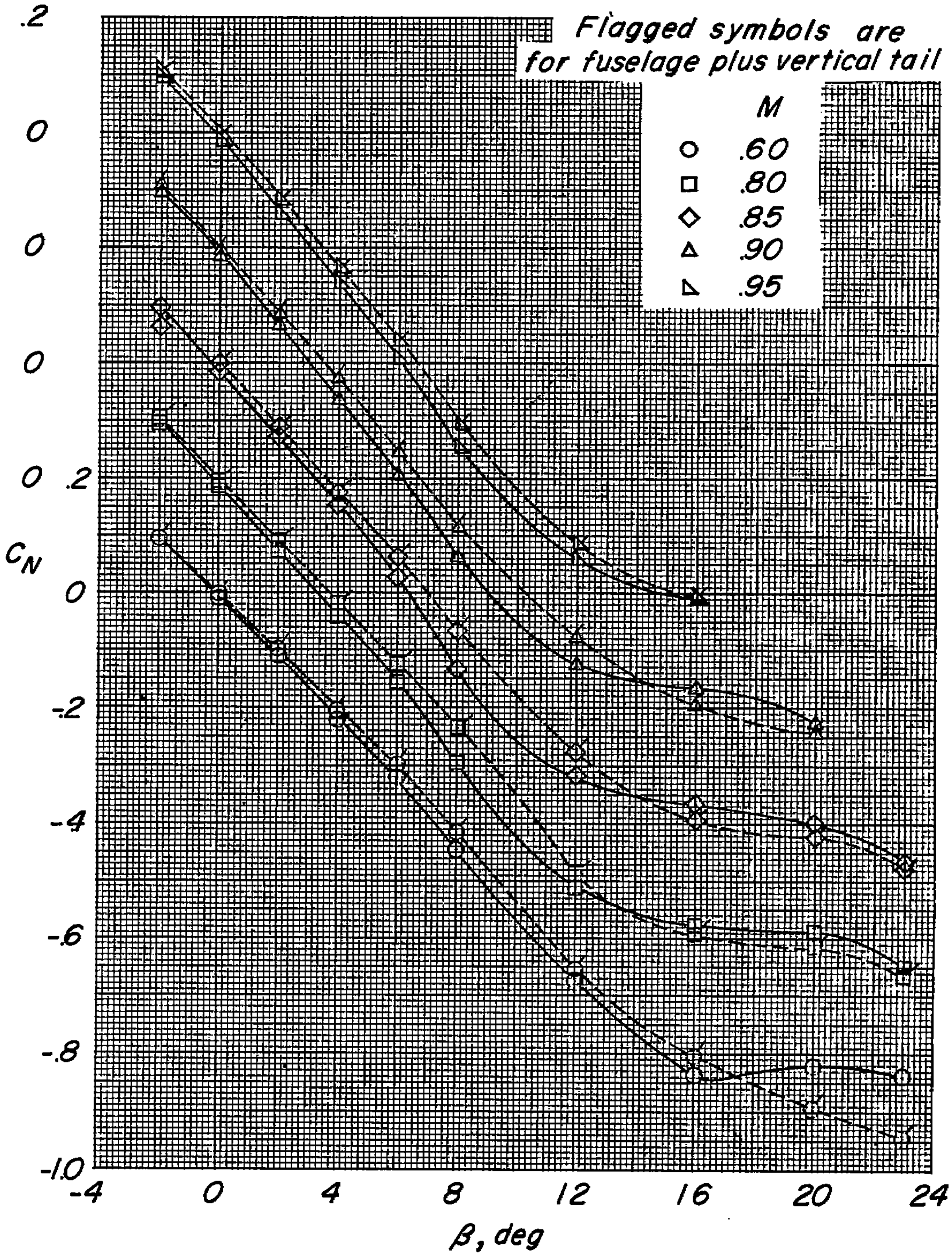
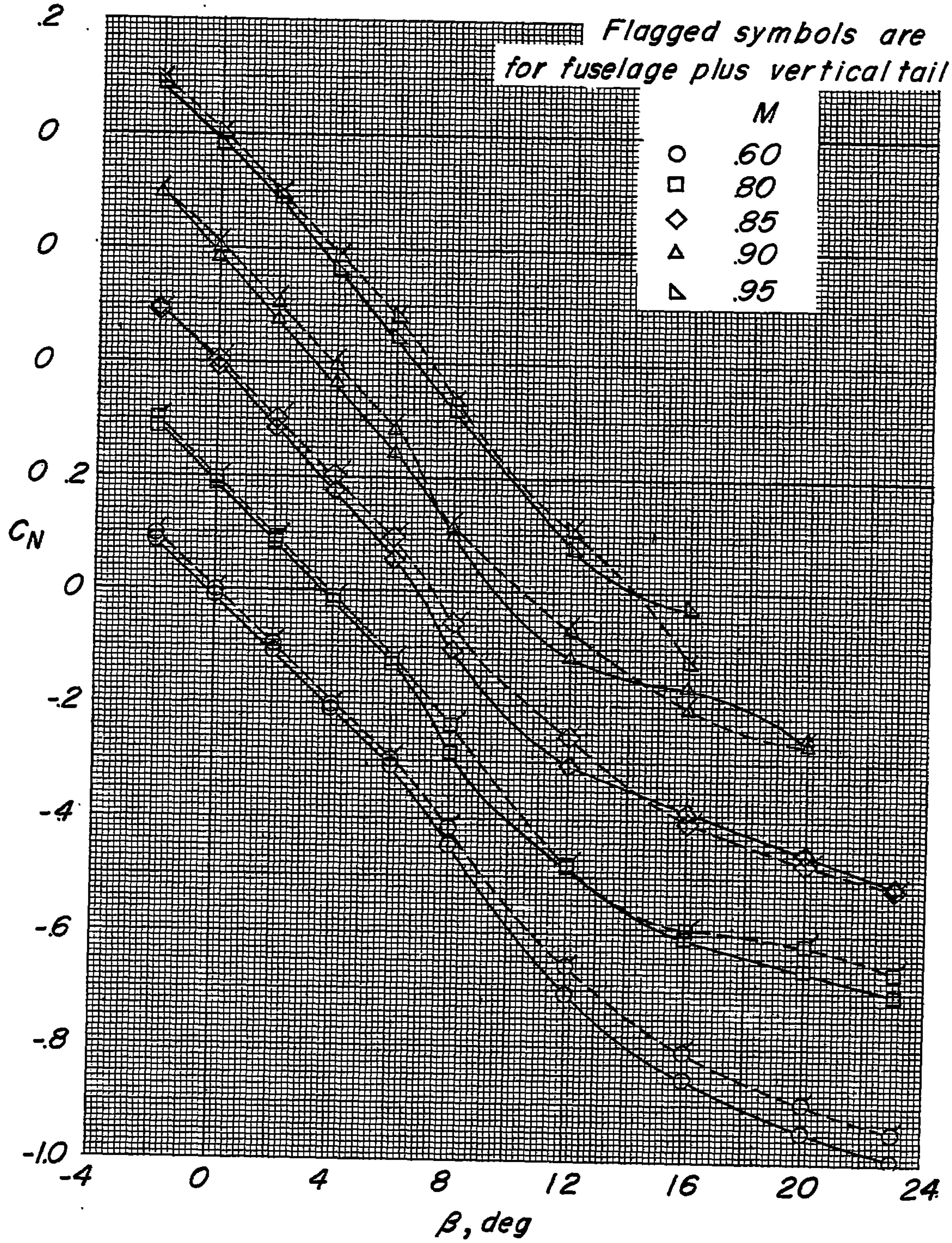


Figure 8.- Variation of section moment coefficient with section normal-force coefficient at $\alpha = 0^{\circ}$. (Symbols without flags are for fuselage plus vertical and horizontal tails.)



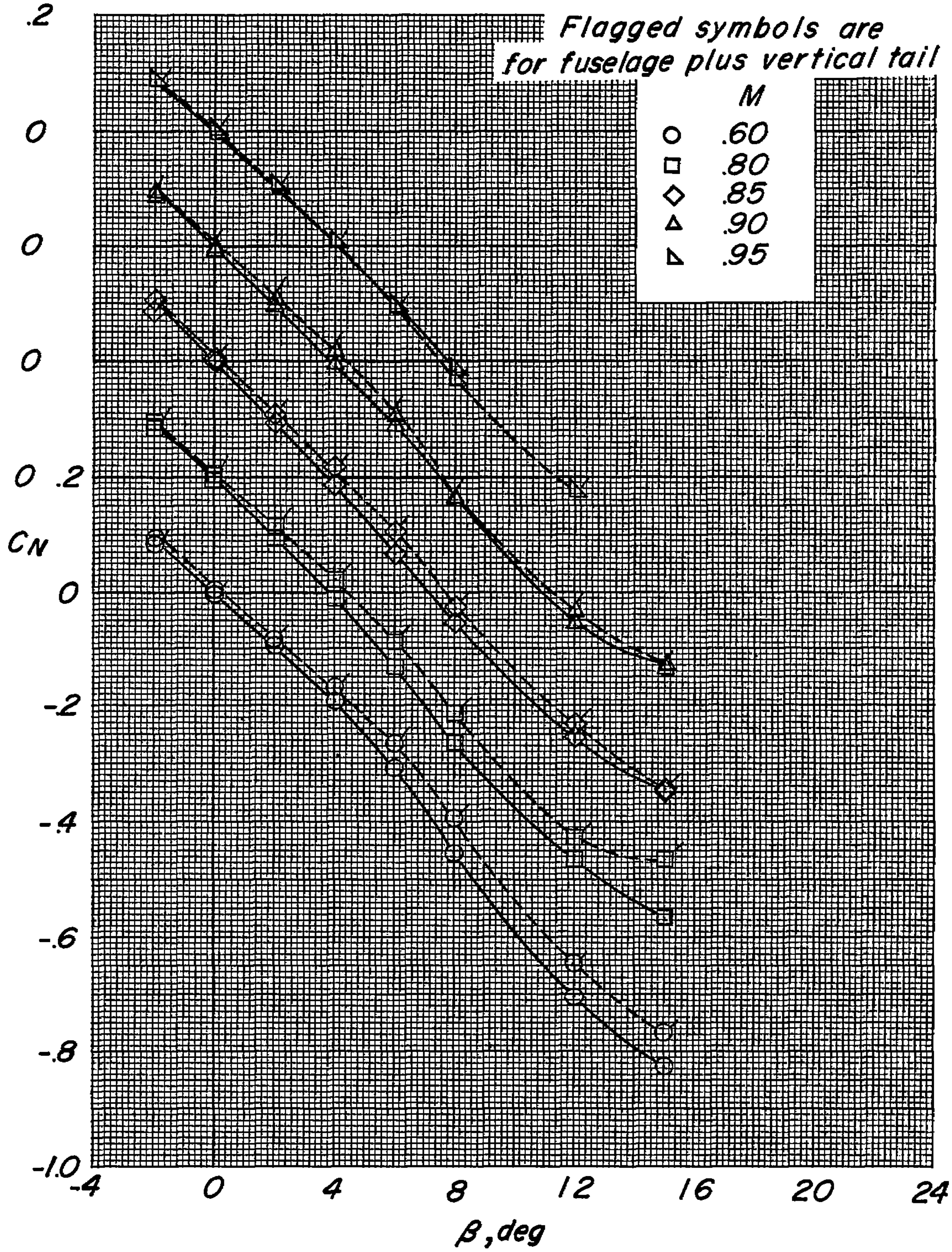
(a) α = 0°.

Figure 9.- Variation of normal-force coefficient with angle of sideslip for various Mach numbers and angles of attack. (Symbols without flags are for fuselage plus vertical and horizontal tails.)



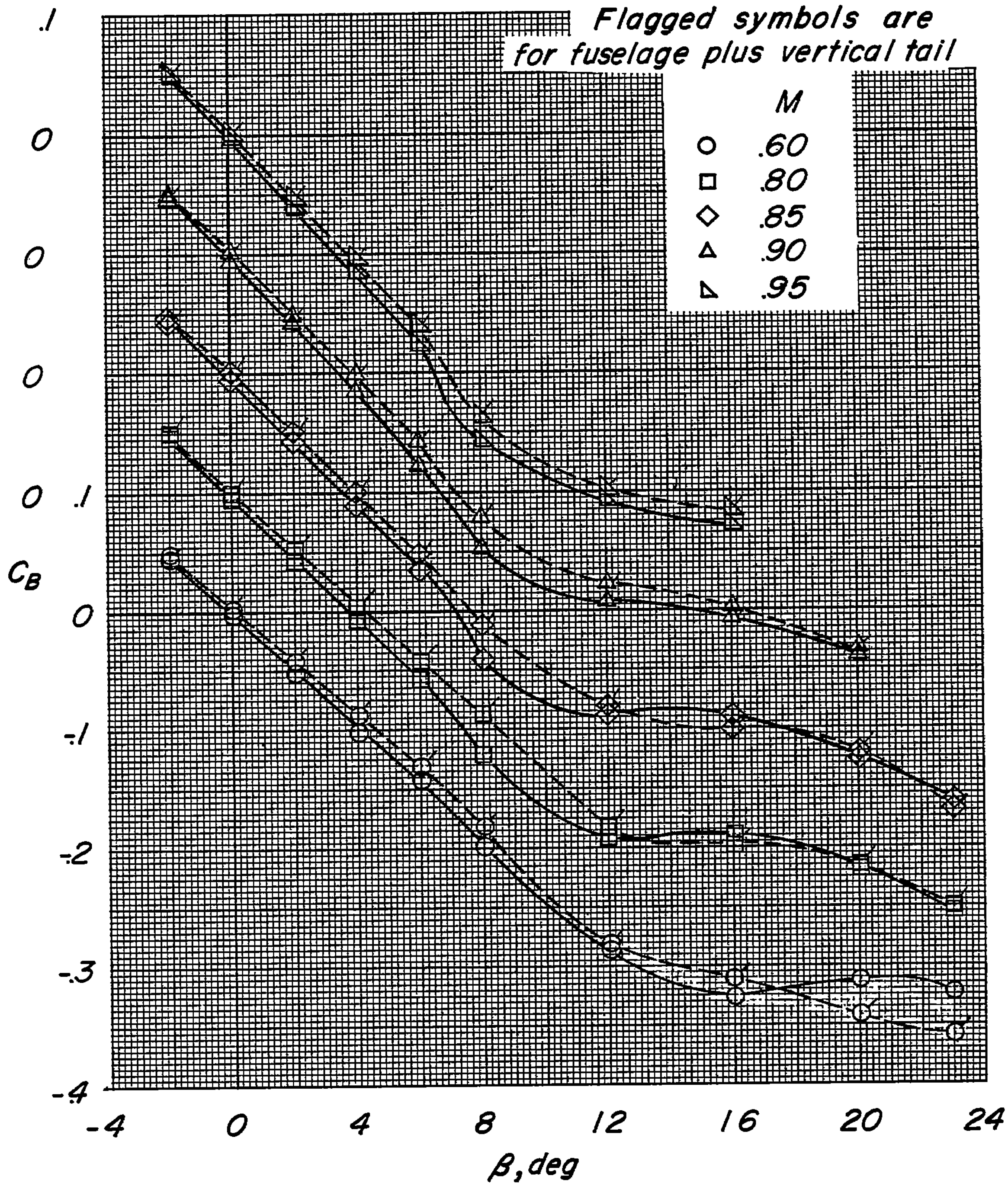
(b) $\alpha = 4^{\circ}$.

Figure 9.- Continued.



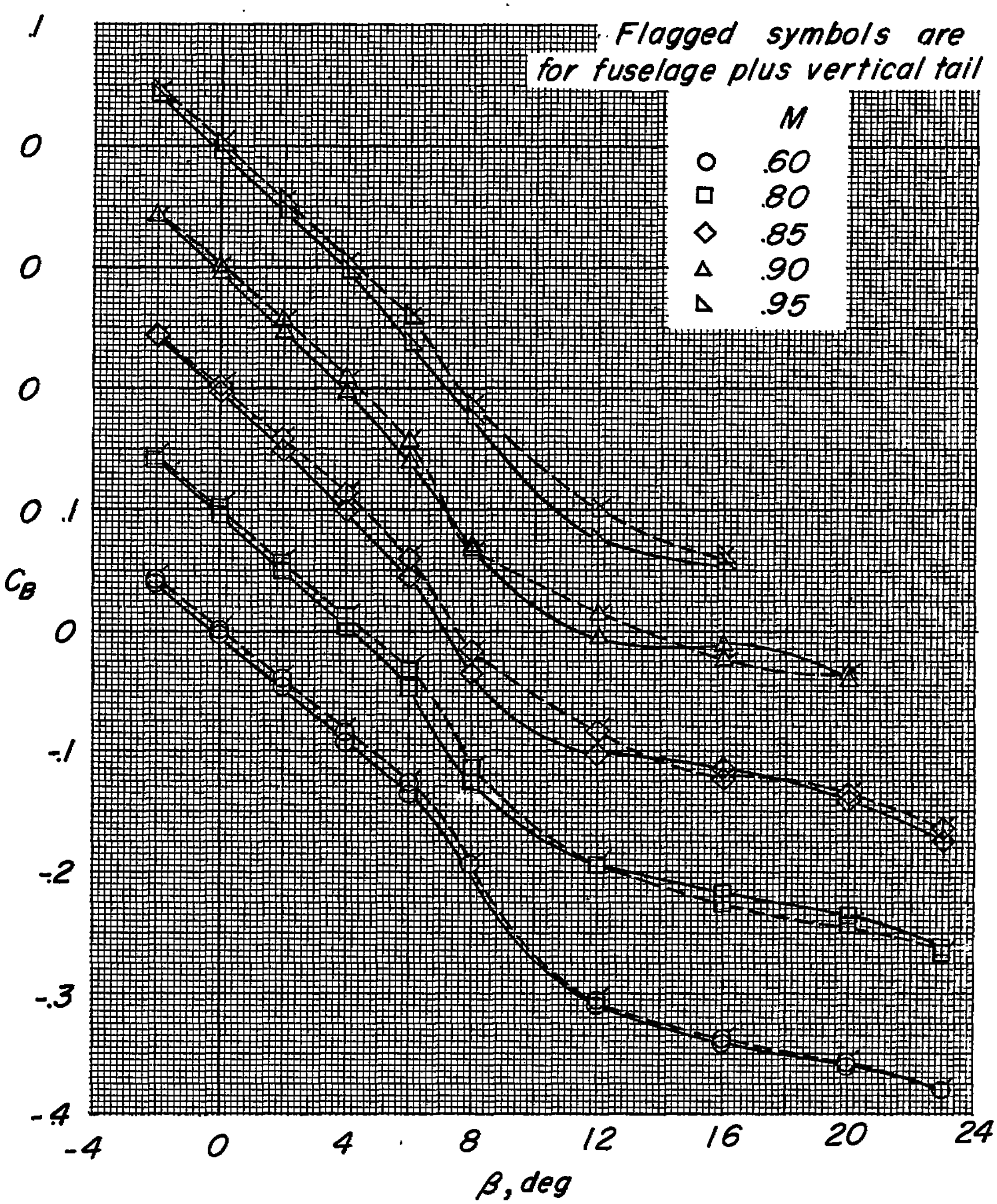
(c) α = 12°.

Figure 9.- Concluded.



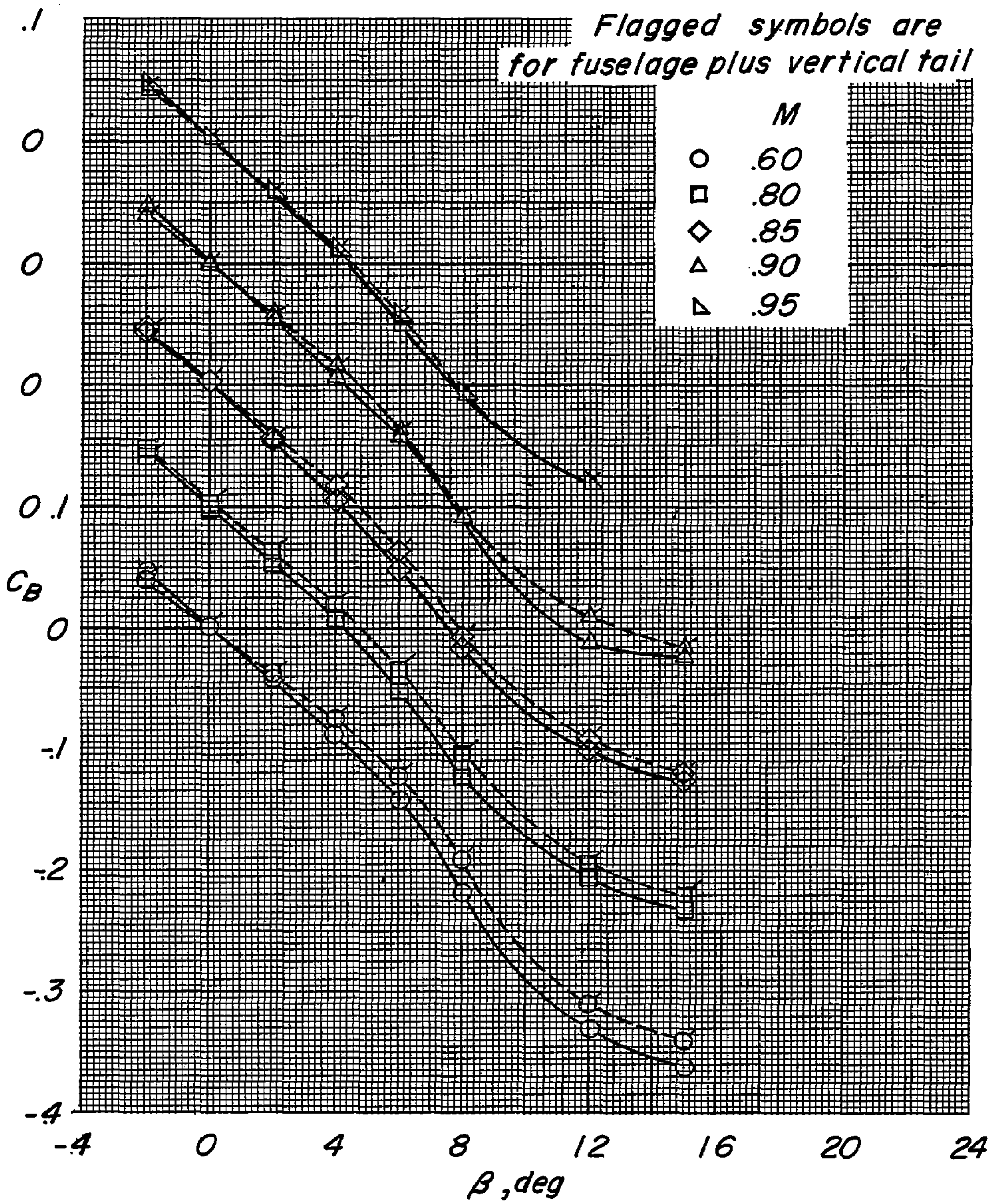
(a) $\alpha = 0^{\circ}$.

Figure 10.- Variation of root-bending-moment coefficient with angle of sideslip for various Mach numbers and angles of attack. (Symbols without flags are for fuselage plus vertical and horizontal tails.)



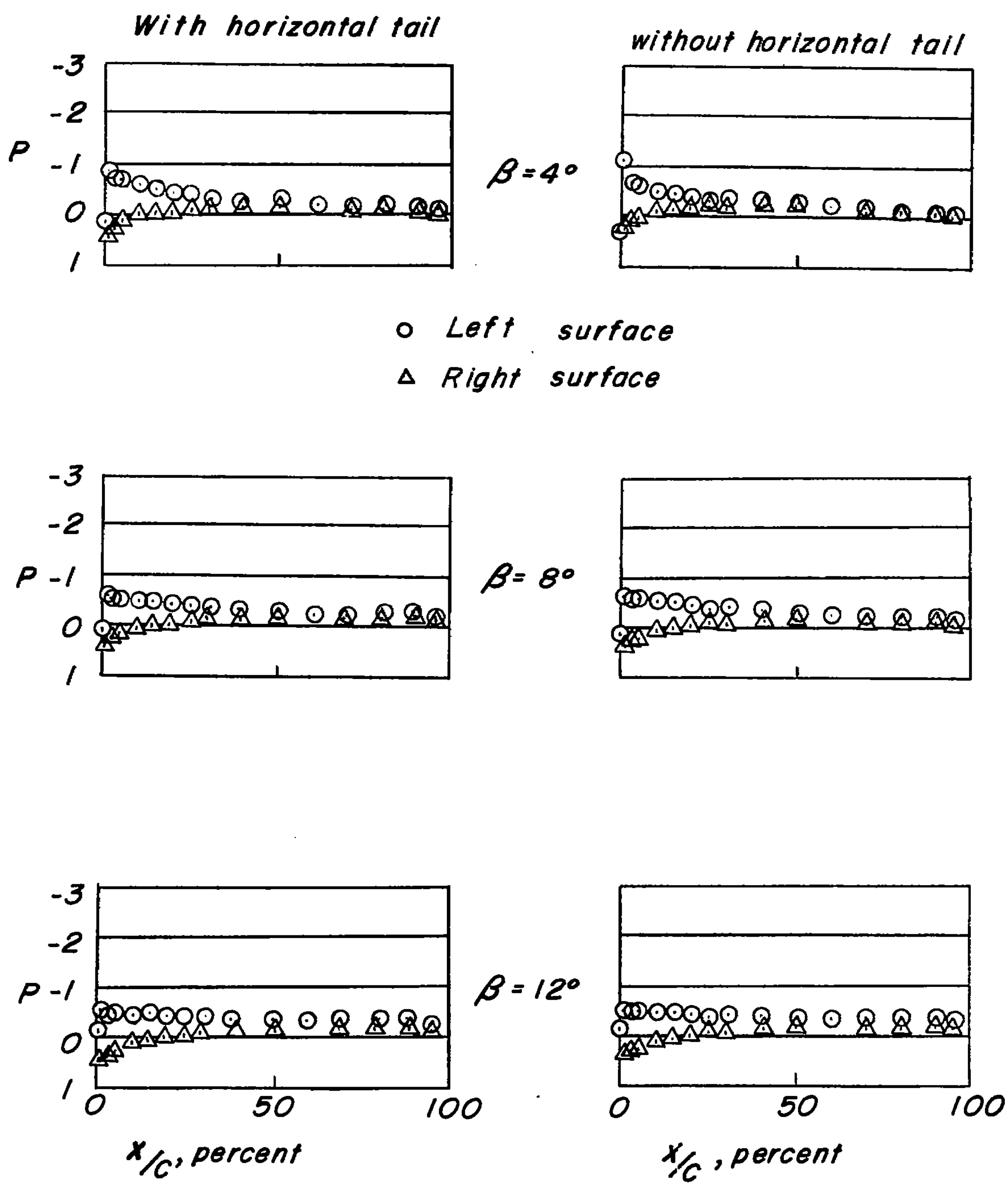
(b) $\alpha = 4^{\circ}$.

Figure 10.- Continued.



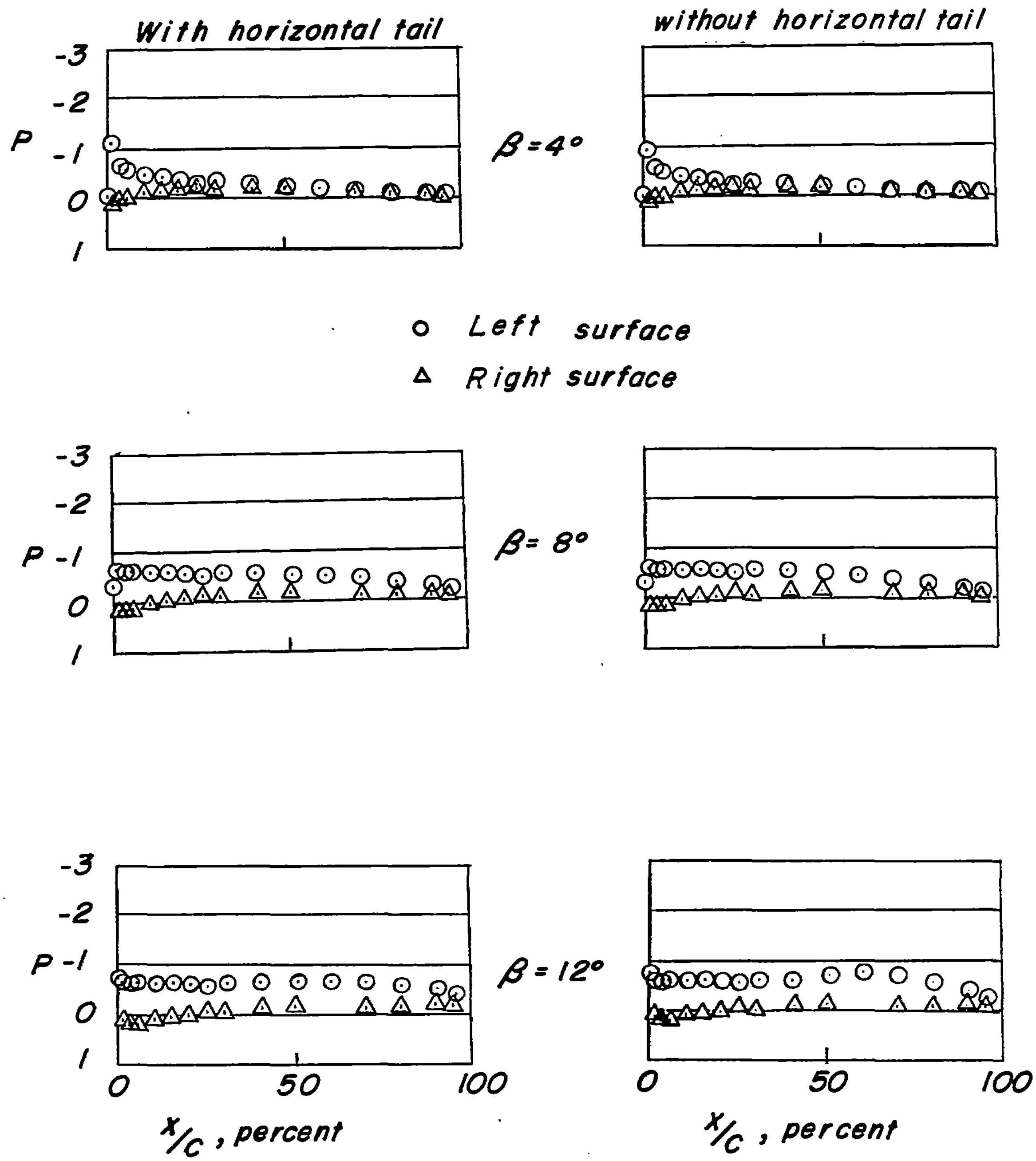
(c) α = 12°.

Figure 10.- Concluded.



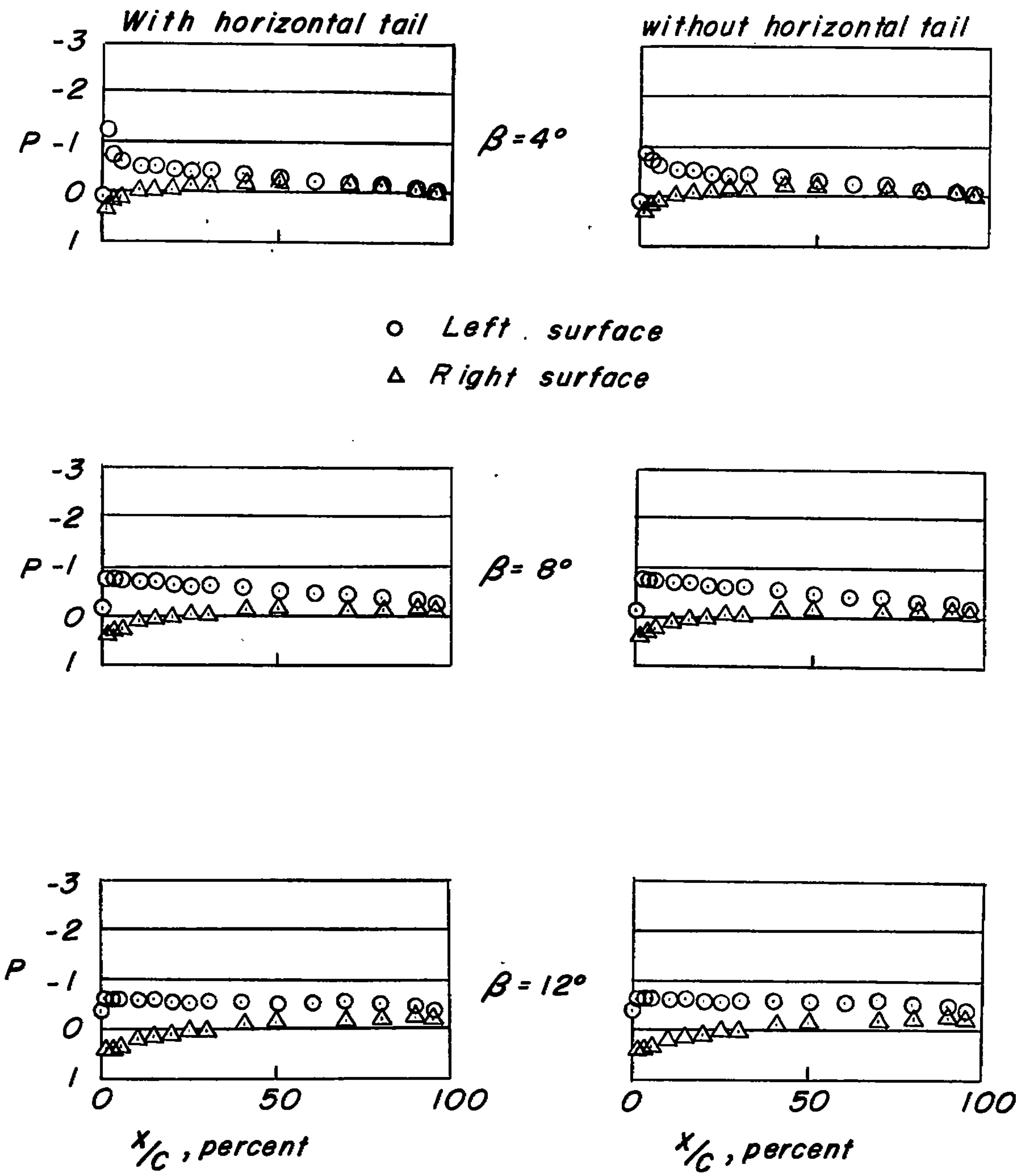
(a) $\alpha = 0^{\circ}$.

Figure 11.- Pressure distribution on vertical tail. Station $0.931b_v$; M = 0.60.



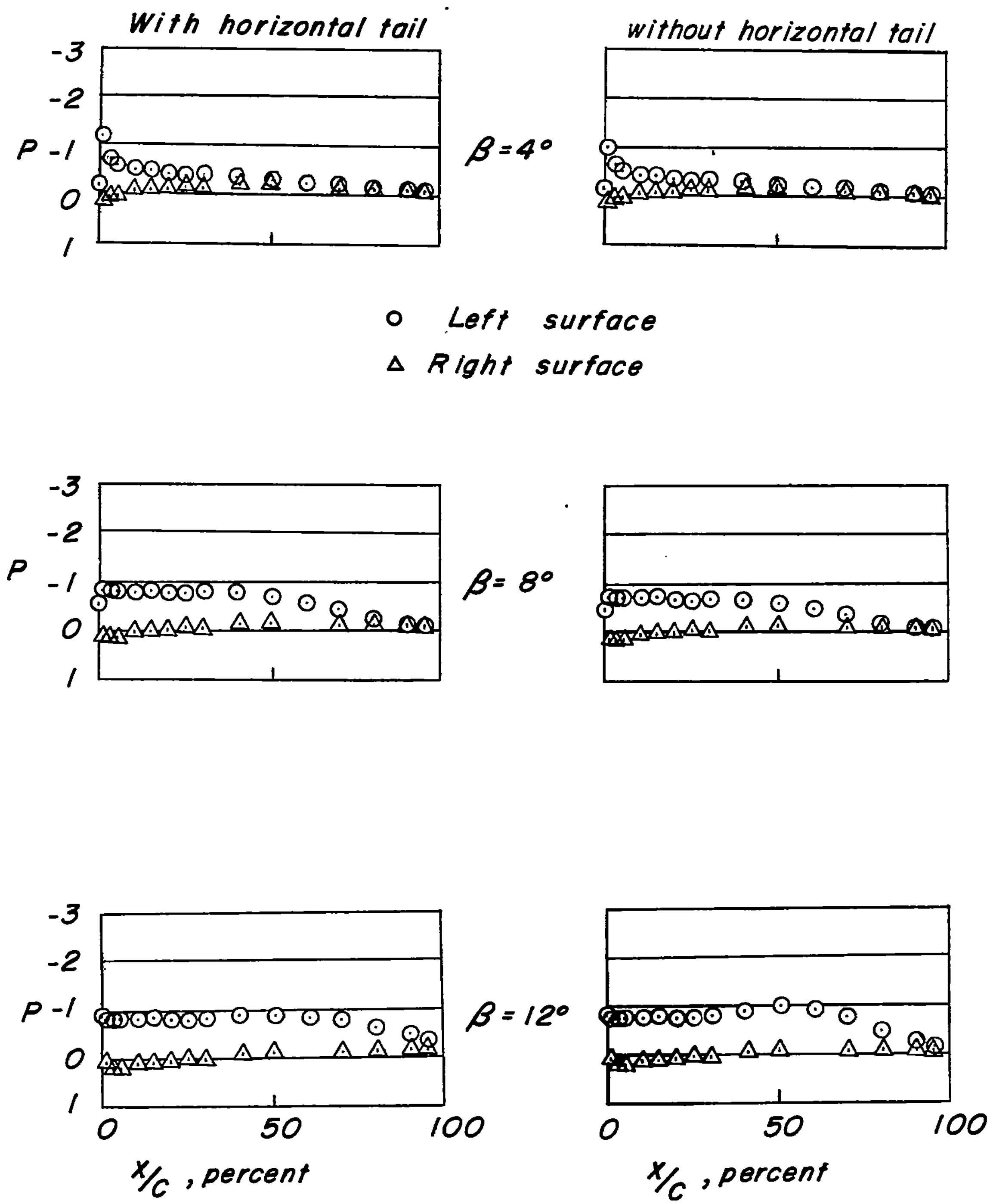
(b) $\alpha = 12^{\circ}$.

Figure 11.- Concluded.



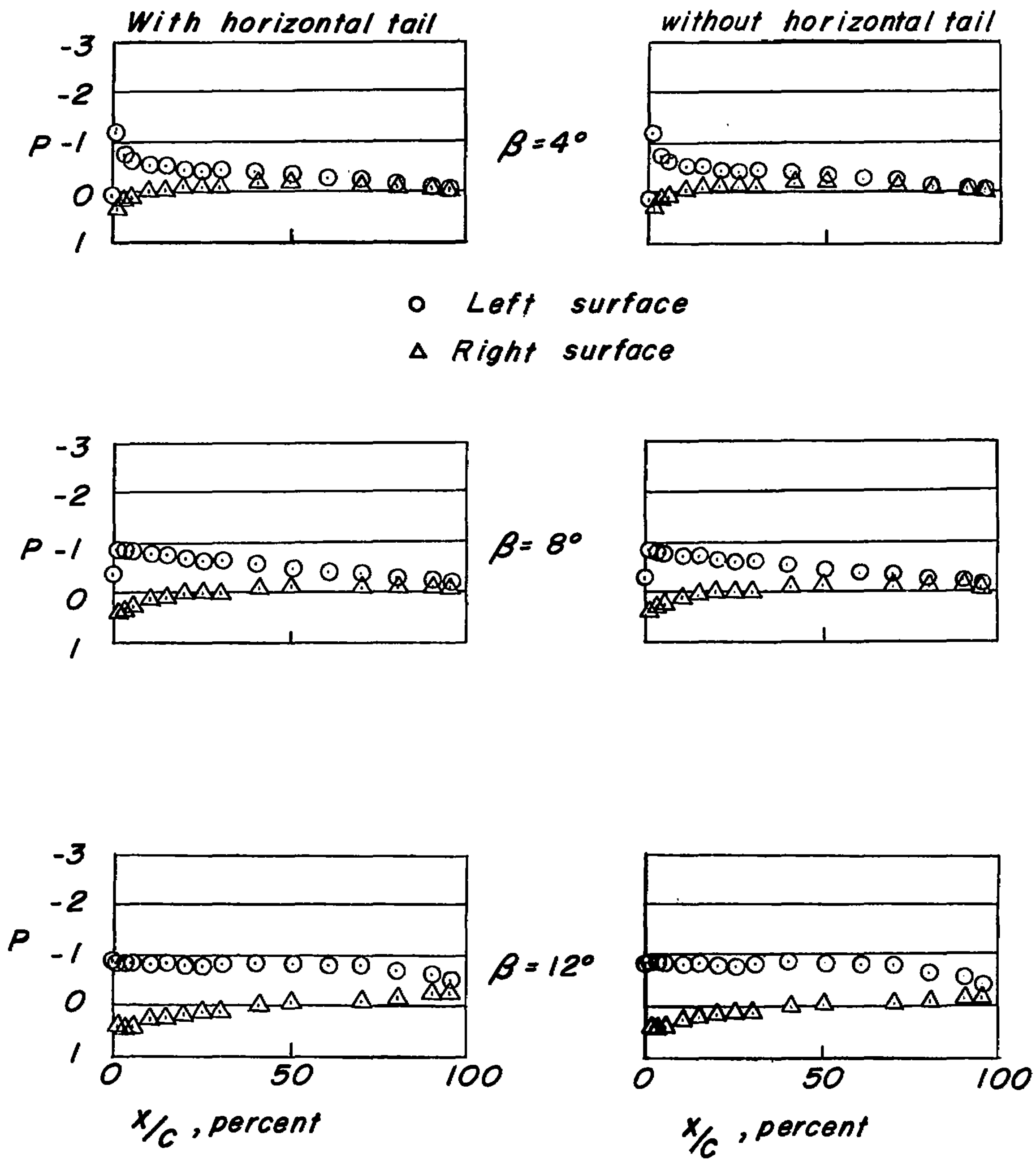
(a) $\alpha = 0^{\circ}$.

Figure 12.- Pressure distribution on vertical tail. Station $0.850b_v$; $M = 0.60$.



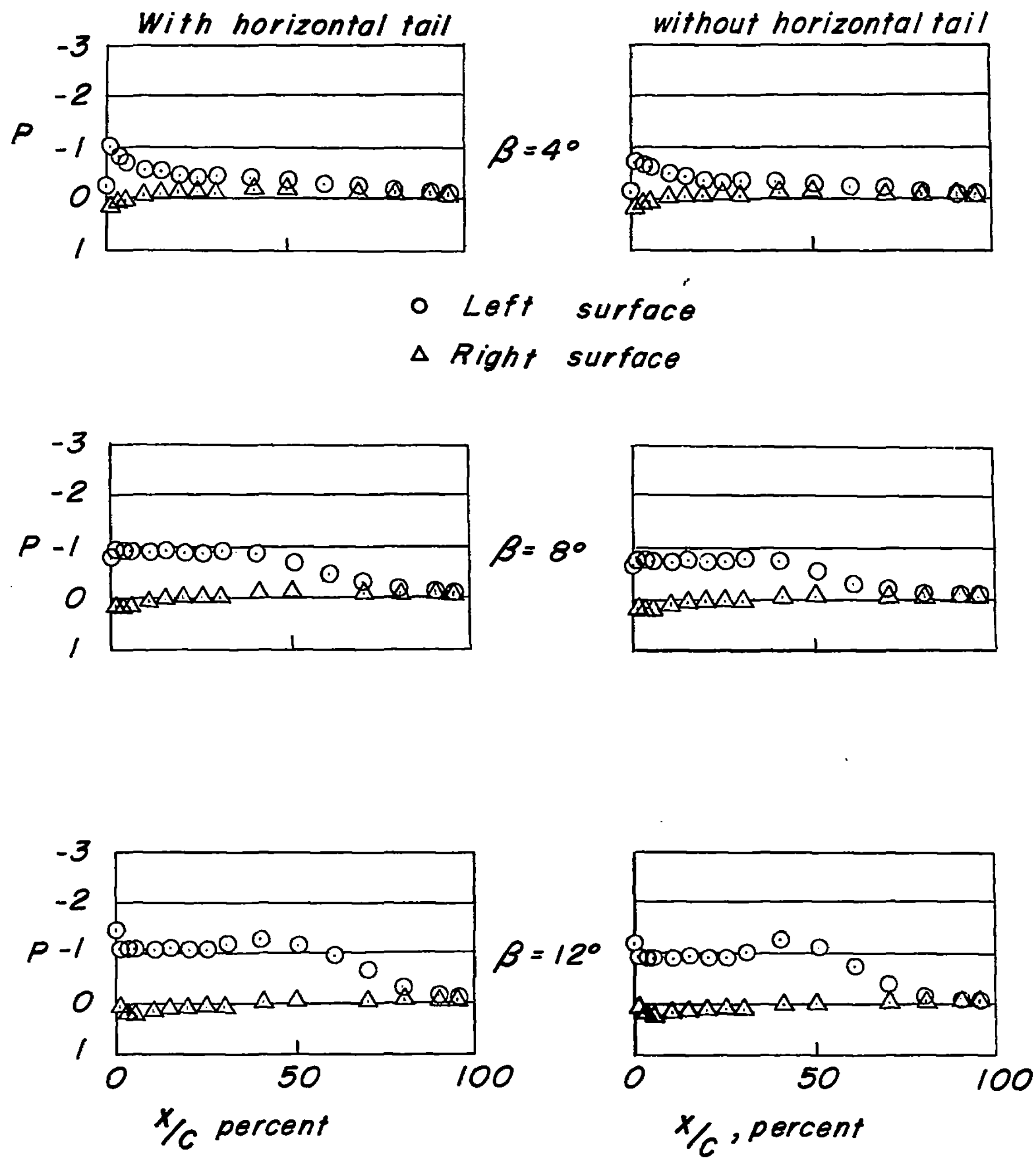
(b) $\alpha = 12^\circ$.

Figure 12.- Concluded.



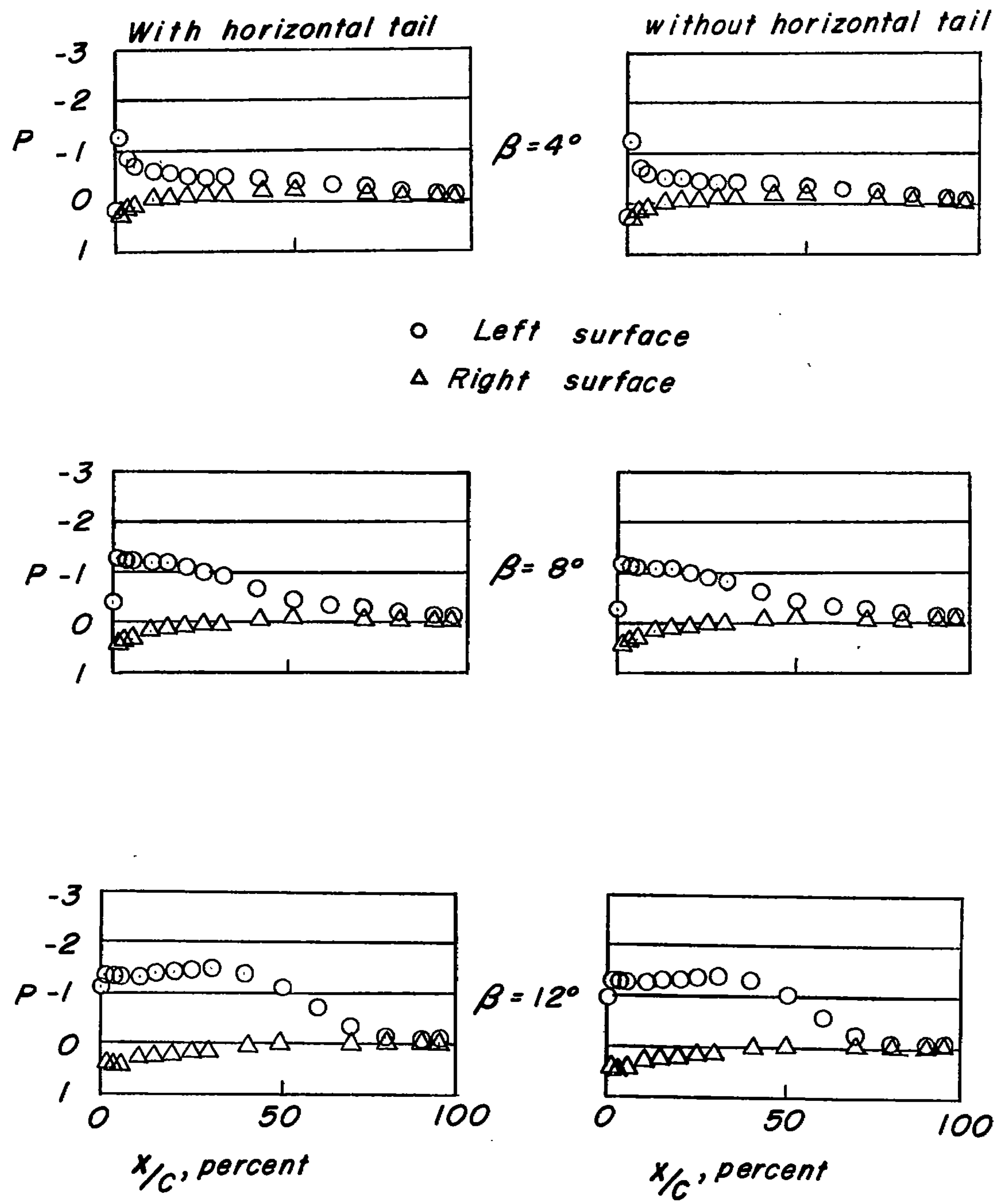
(a) $\alpha = 0^{\circ}$.

Figure 13.- Pressure distribution on vertical tail. Station $0.700b_v$; $M = 0.60$.



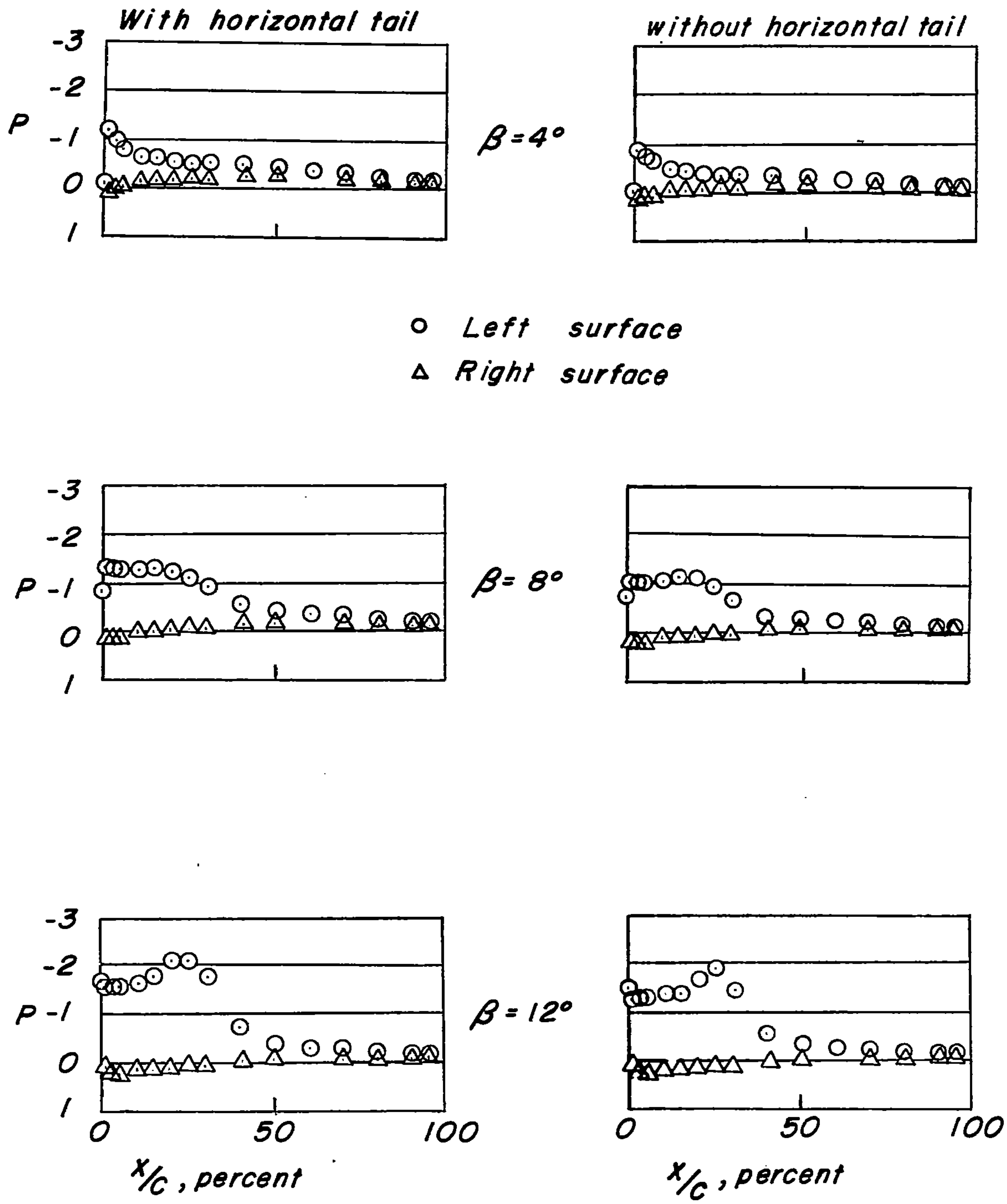
(b) α = 12°.

Figure 13.- Concluded.



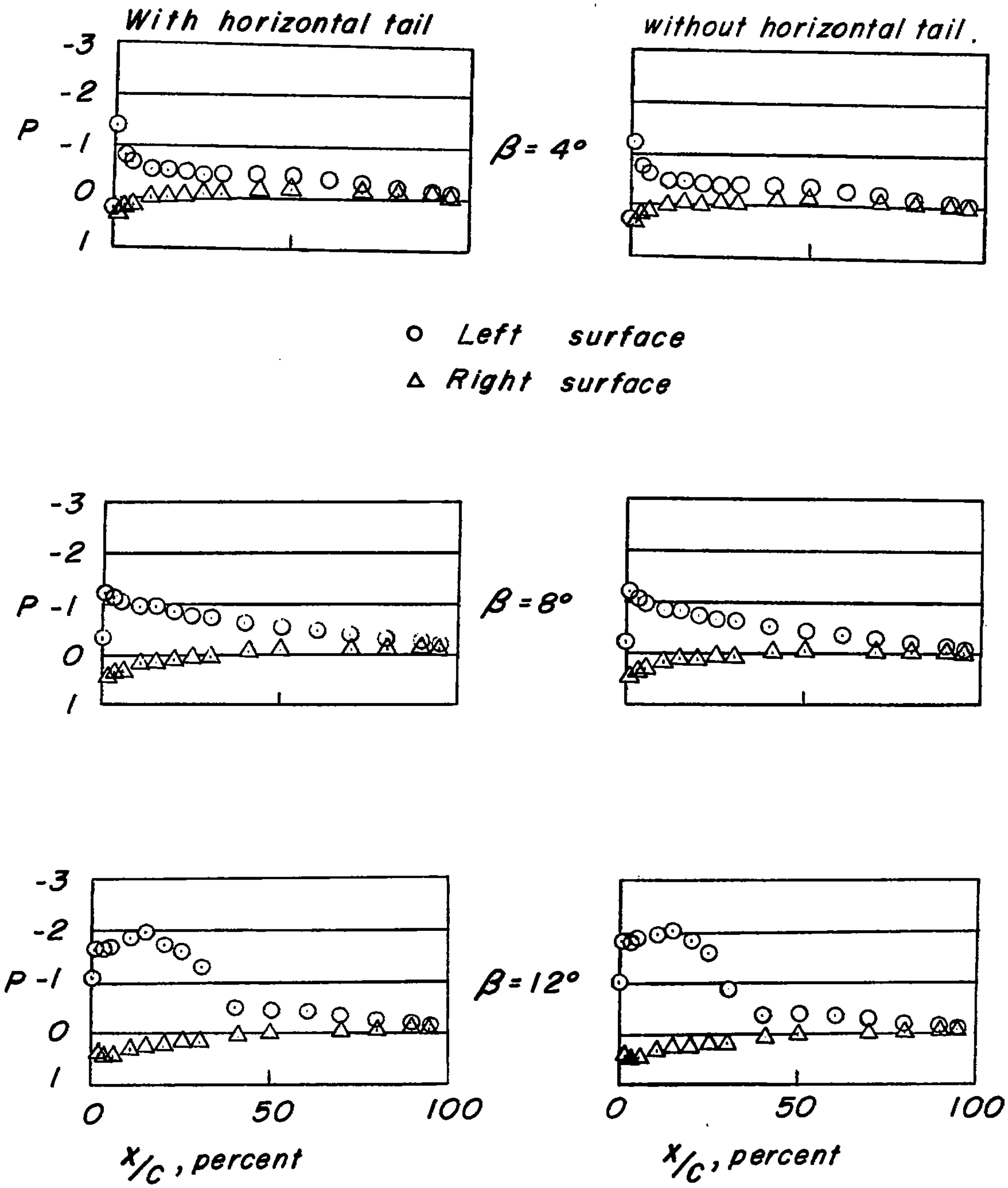
(a) $\alpha = 0^{\circ}$.

Figure 14.- Pressure distribution on vertical tail. Station $0.450b_v$; $M = 0.60$.



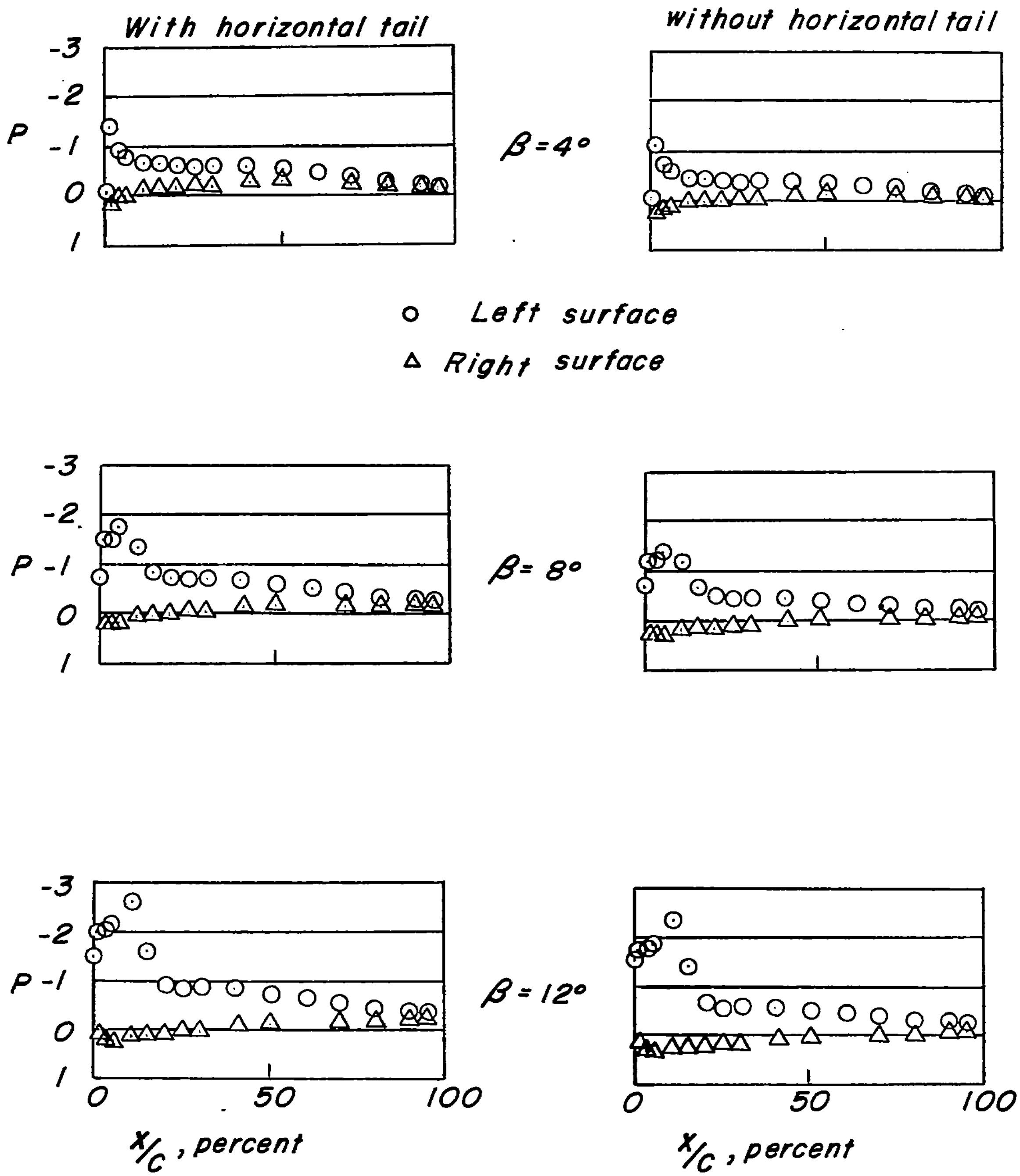
(b) $\alpha = 12^{\circ}$.

Figure 14.- Concluded.



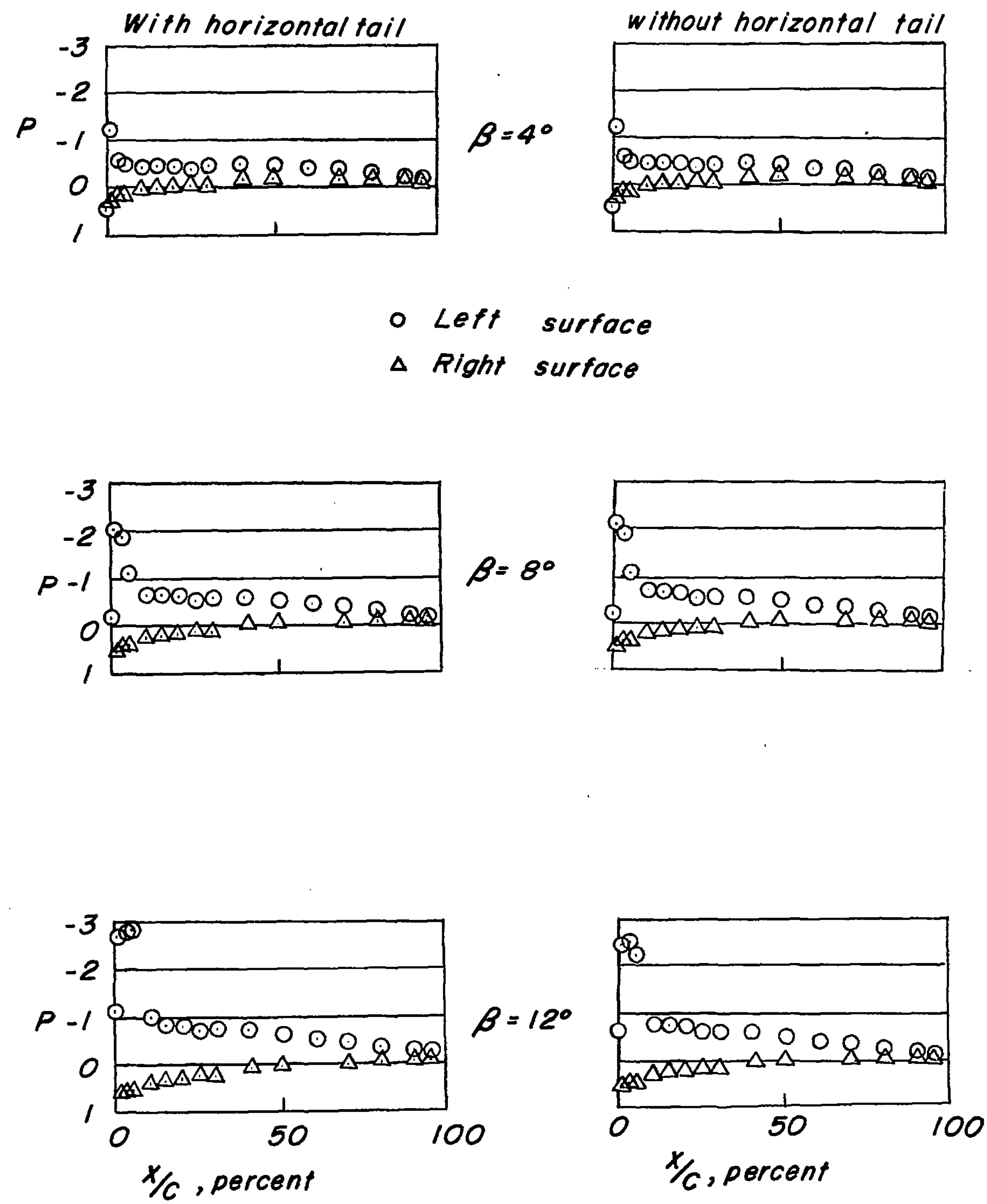
(a) $\alpha = 0^{\circ}$.

Figure 15.- Pressure distribution on vertical tail. Station $0.300b_V$; $M = 0.60$.



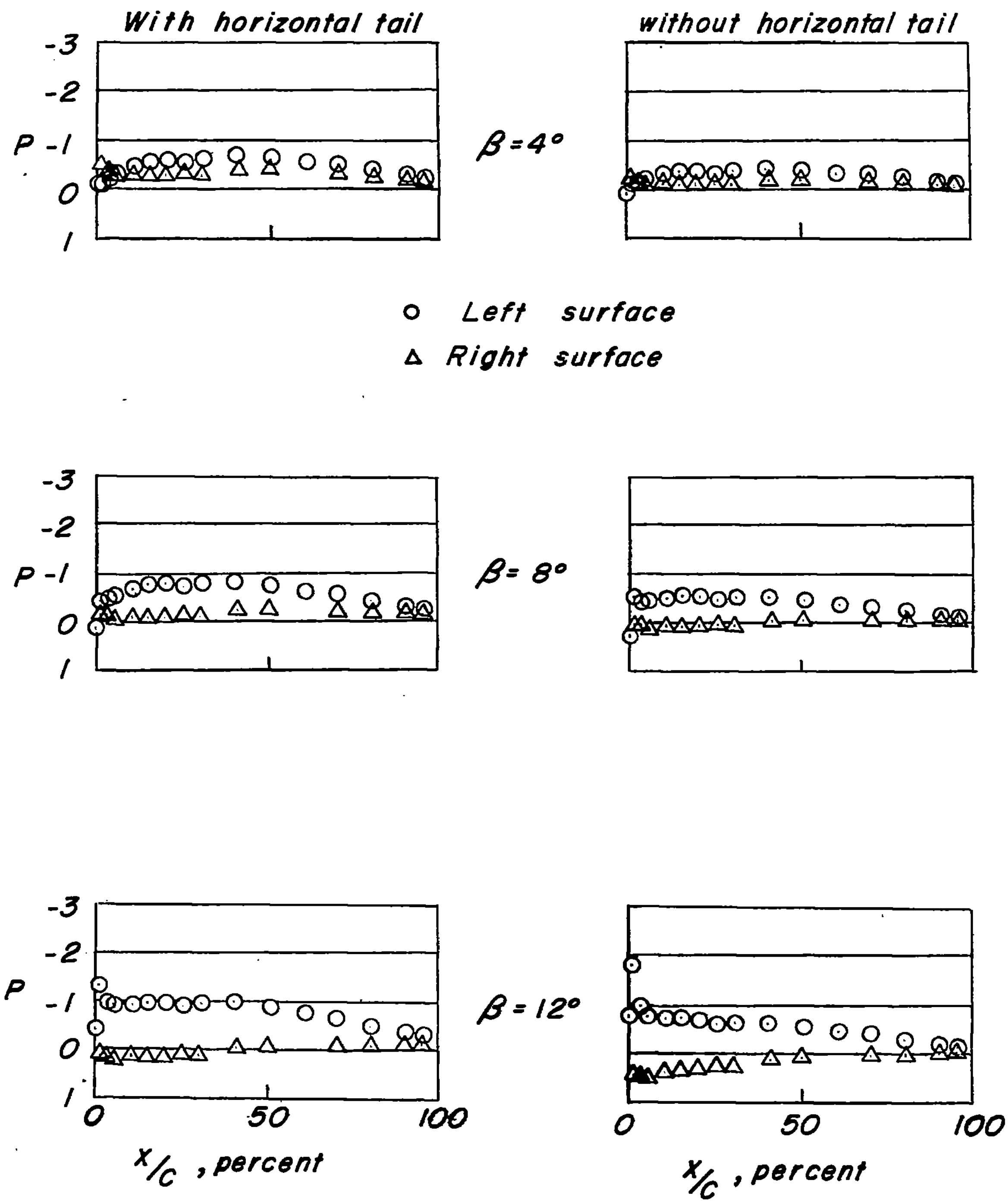
(b) $\alpha = 12^{\circ}$.

Figure 15.- Concluded.



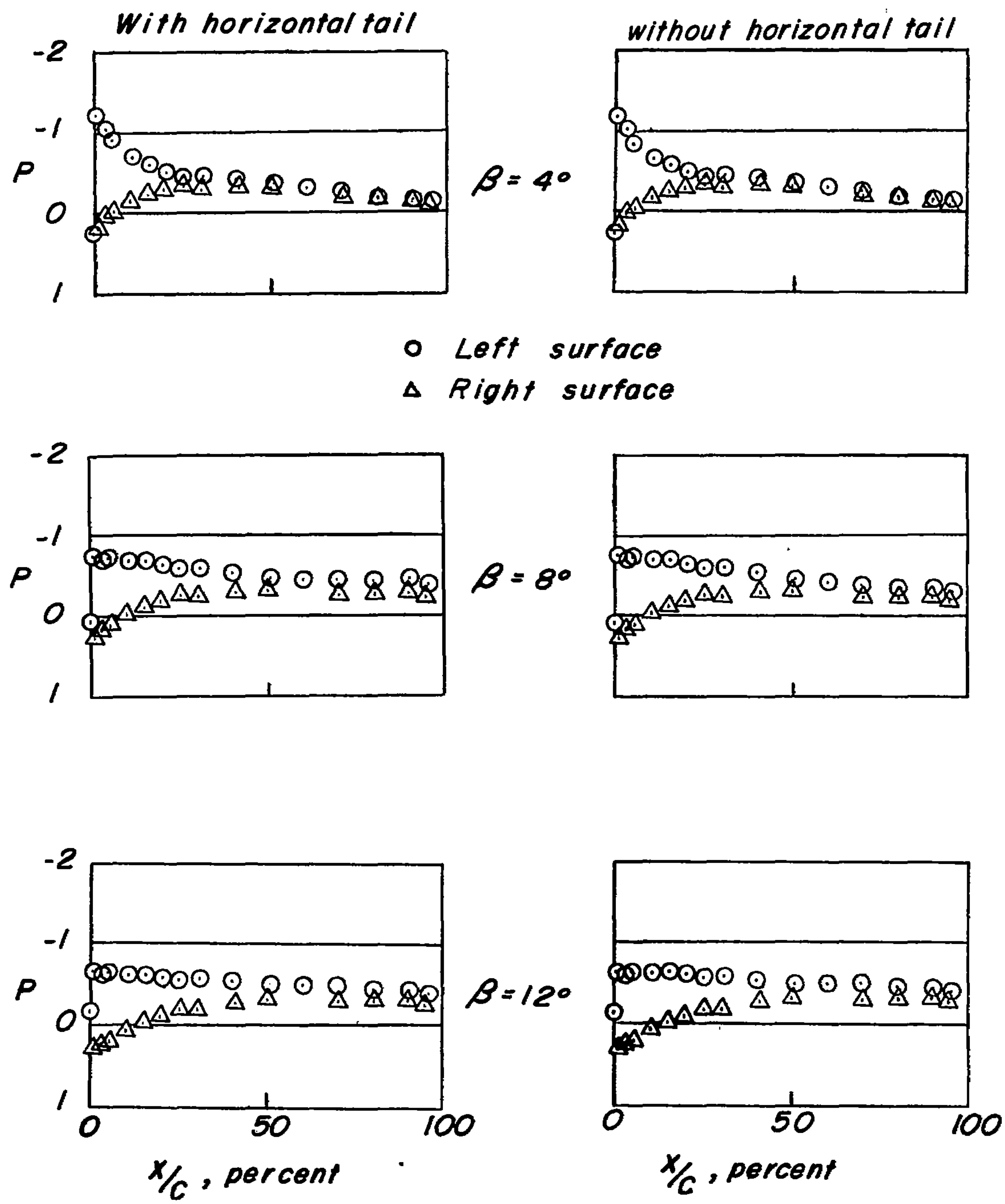
(a) $\alpha = 0^{\circ}$.

Figure 16.- Pressure distribution on vertical tail. Station $0.200b_v$; $M = 0.60$.



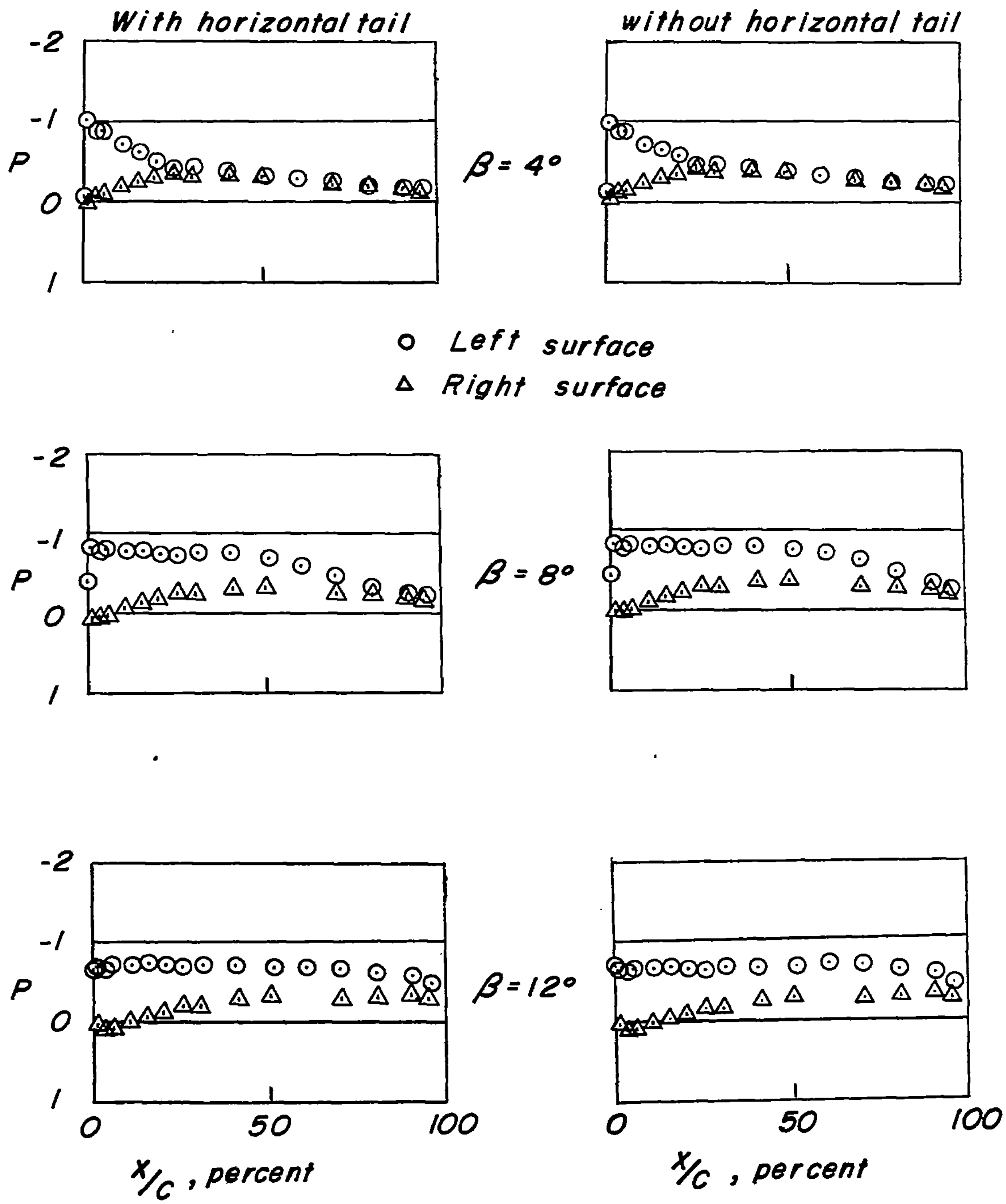
(b) $\alpha = 12^{\circ}$.

Figure 16.- Concluded.



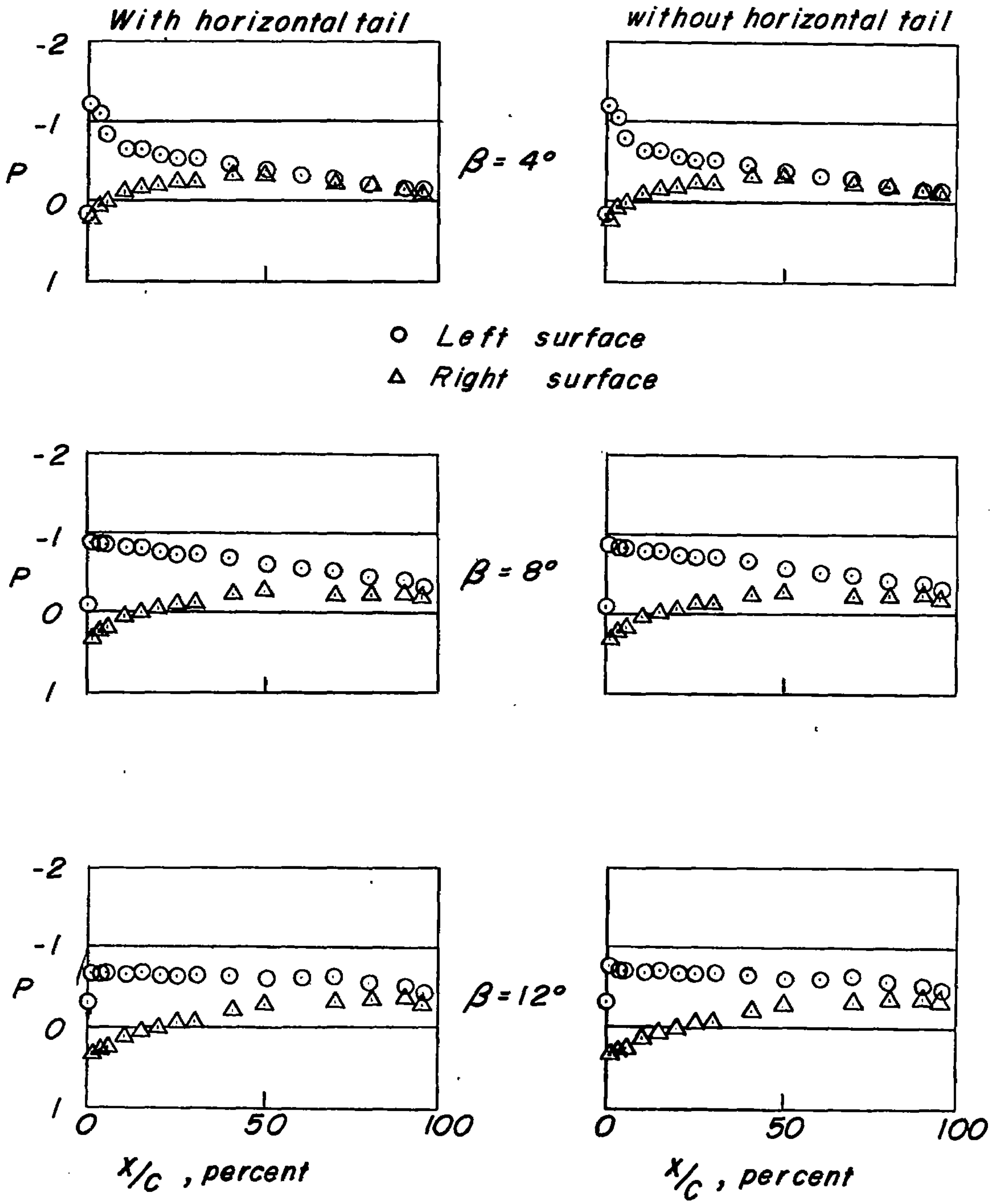
(a) $\alpha = 0^{\circ}$.

Figure 17.- Pressure distribution on vertical tail. Station $0.931b_V$; $M = 0.85$.



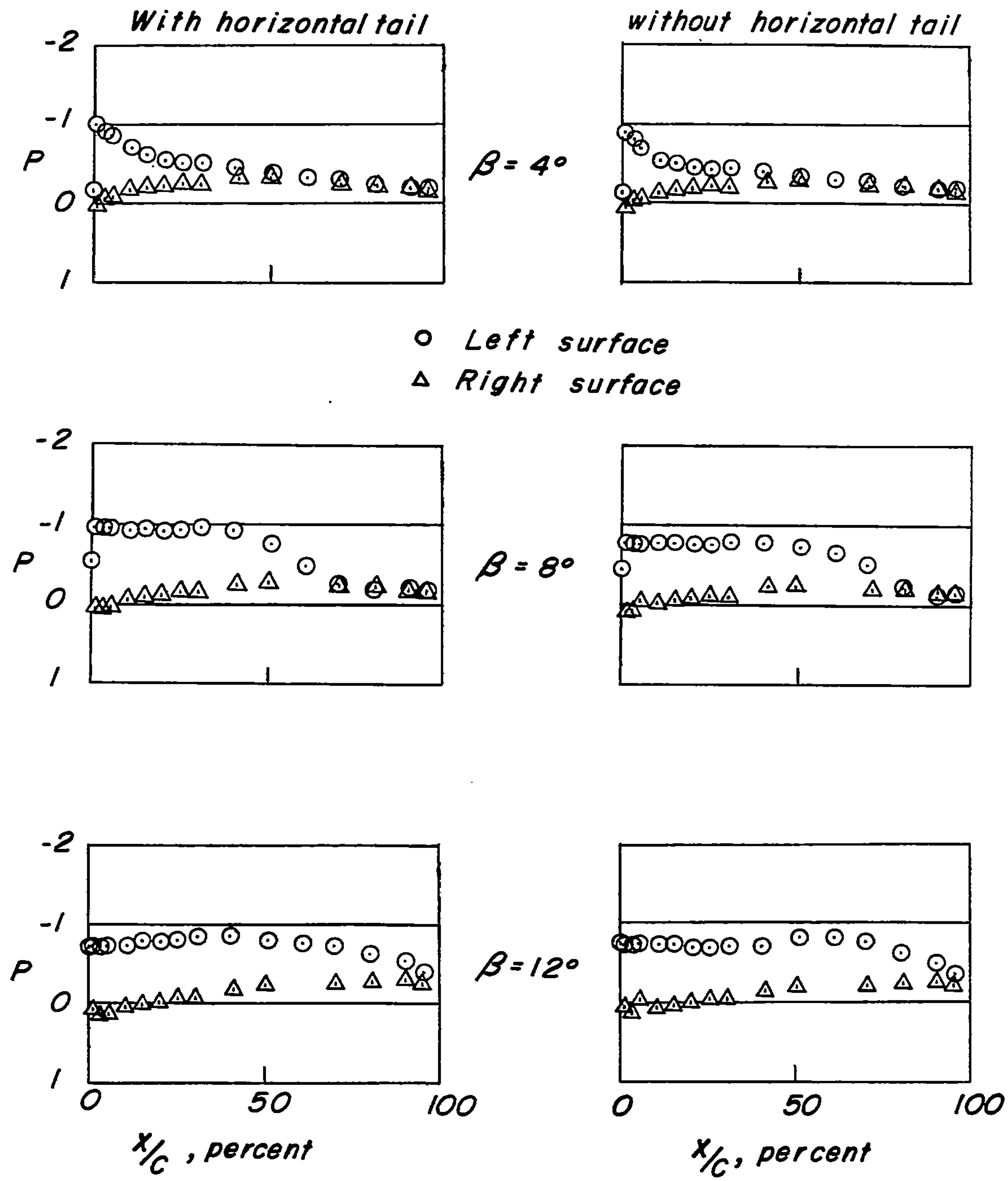
(b) $\alpha = 12^{\circ}$.

Figure 17.- Concluded.



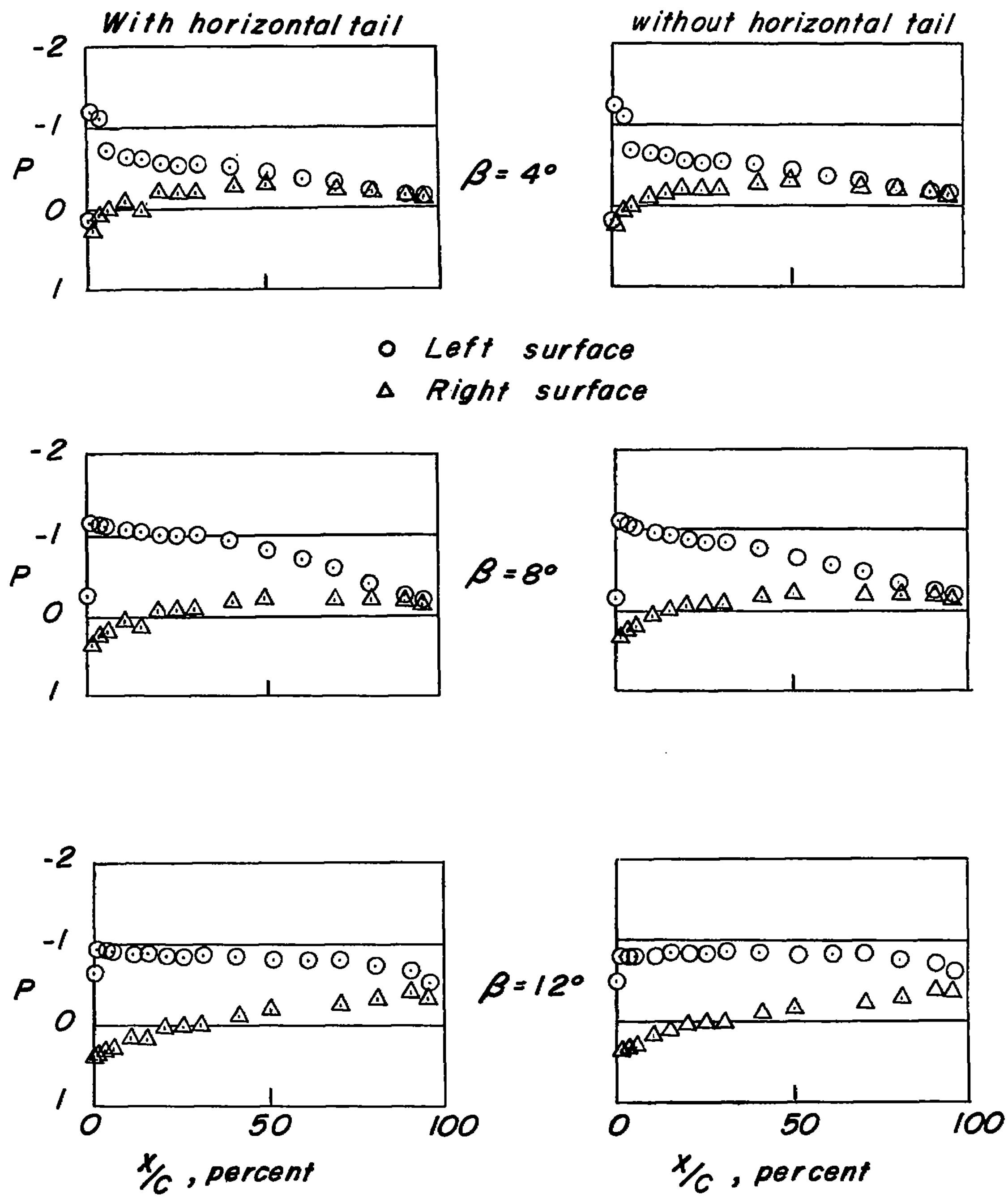
(a) $\alpha = 0^{\circ}$.

Figure 18.- Pressure distribution on vertical tail. Station $0.850b_v$; $M = 0.85$.



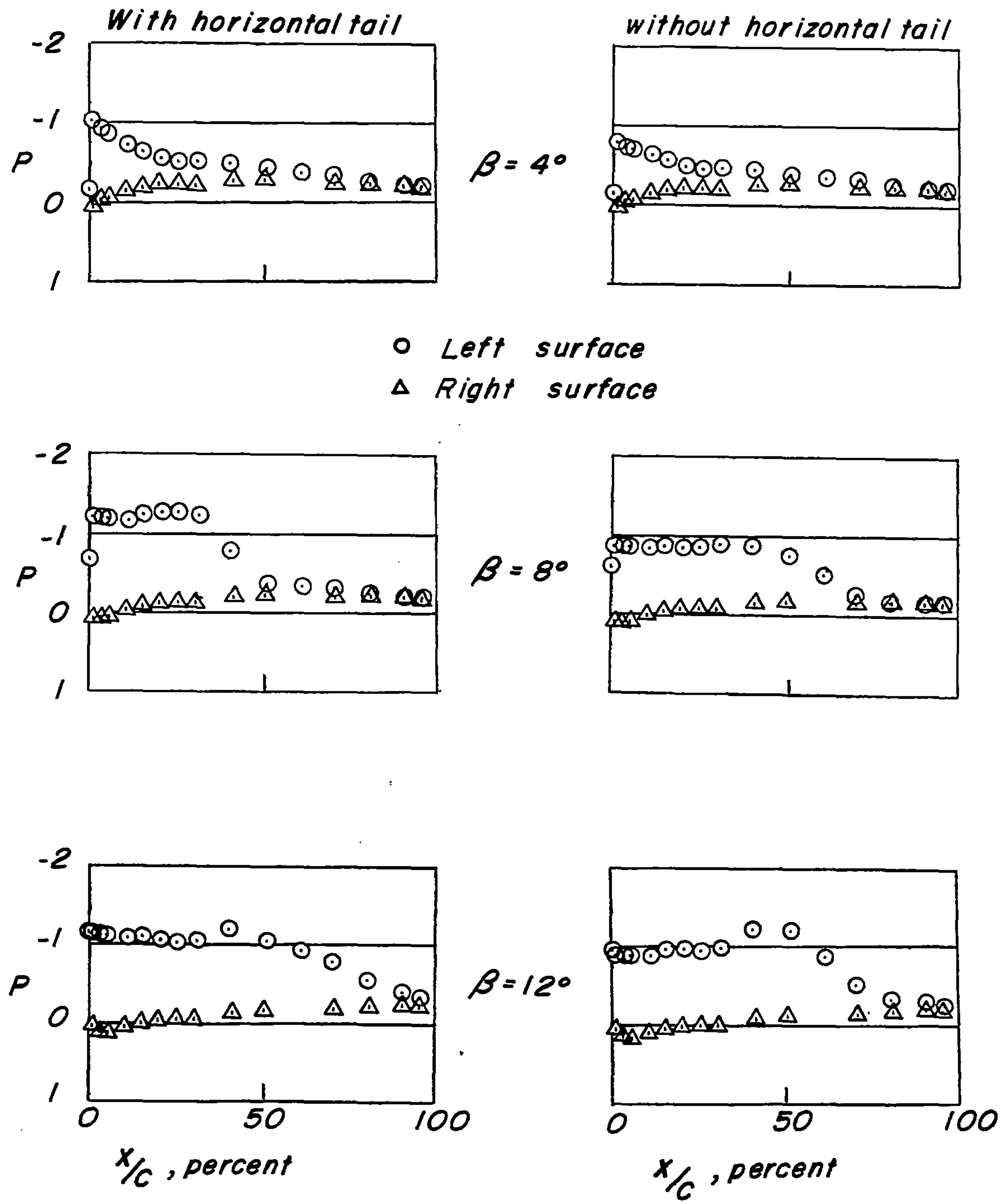
(b) $\alpha = 12^{\circ}$.

Figure 18.- Concluded.



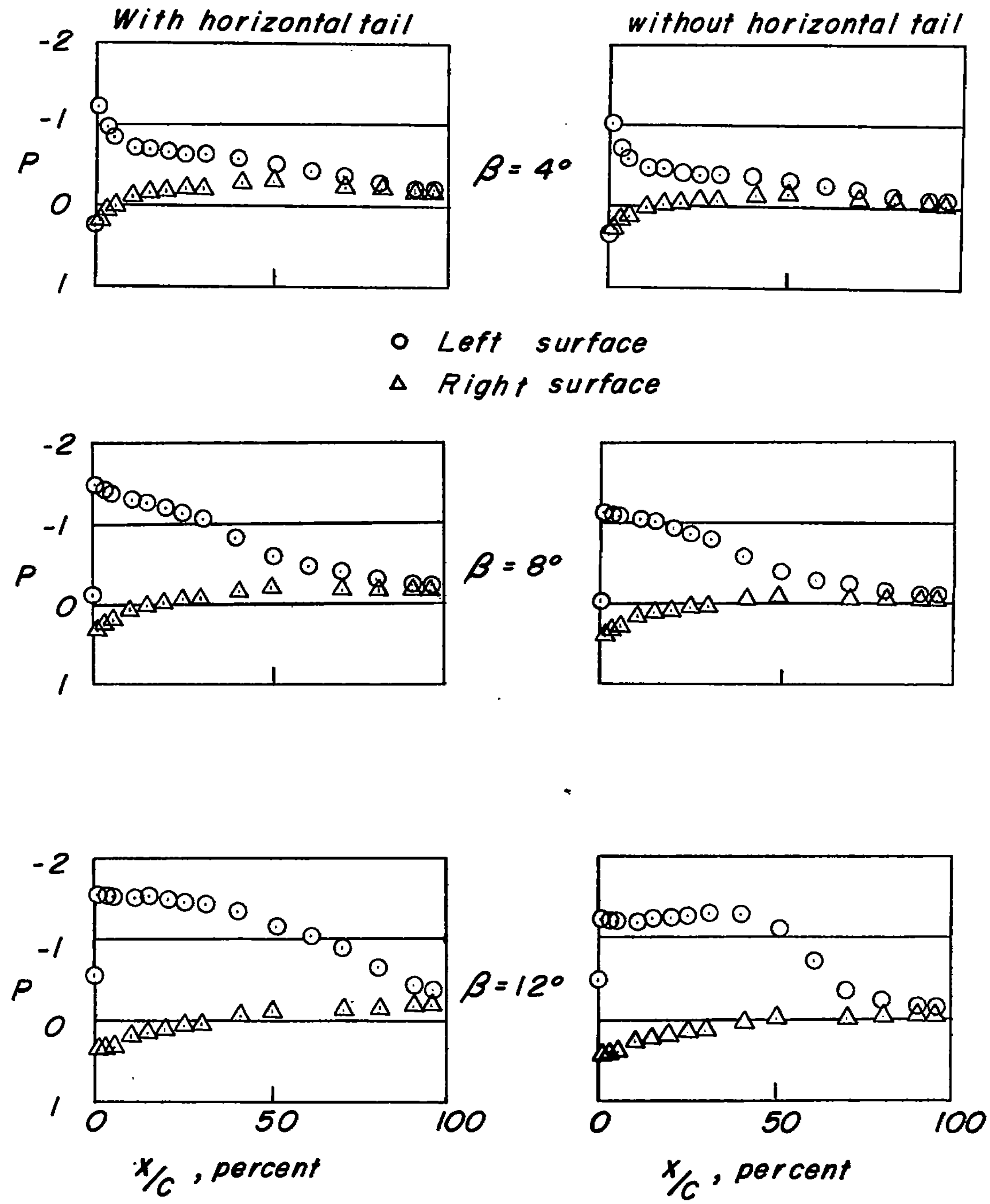
(a) $\alpha = 0^{\circ}$.

Figure 19.- Pressure distribution on vertical tail. Station $0.700b_v$; $M = 0.85$.



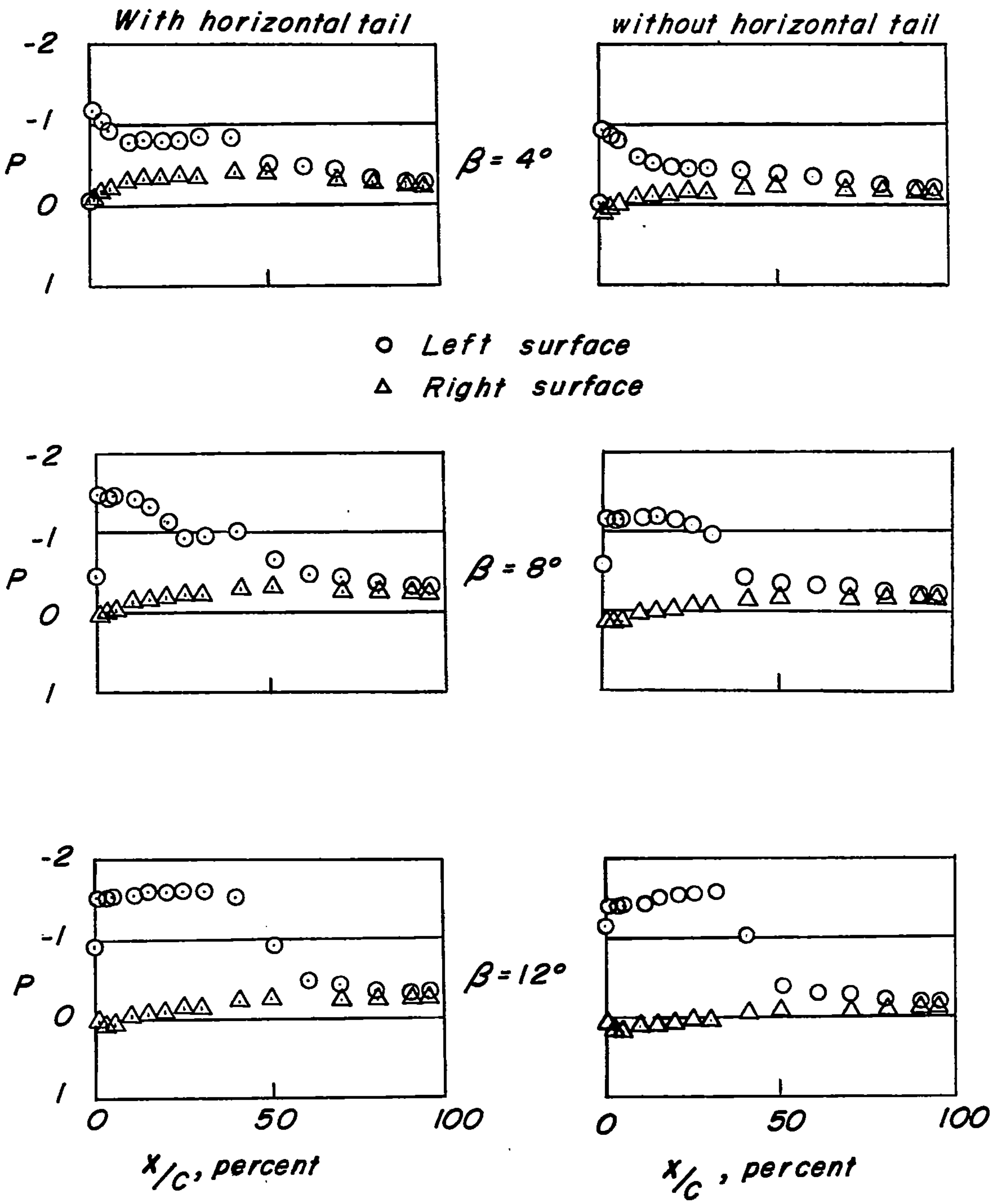
(b) $\alpha = 12^{\circ}$.

Figure 19.- Concluded.



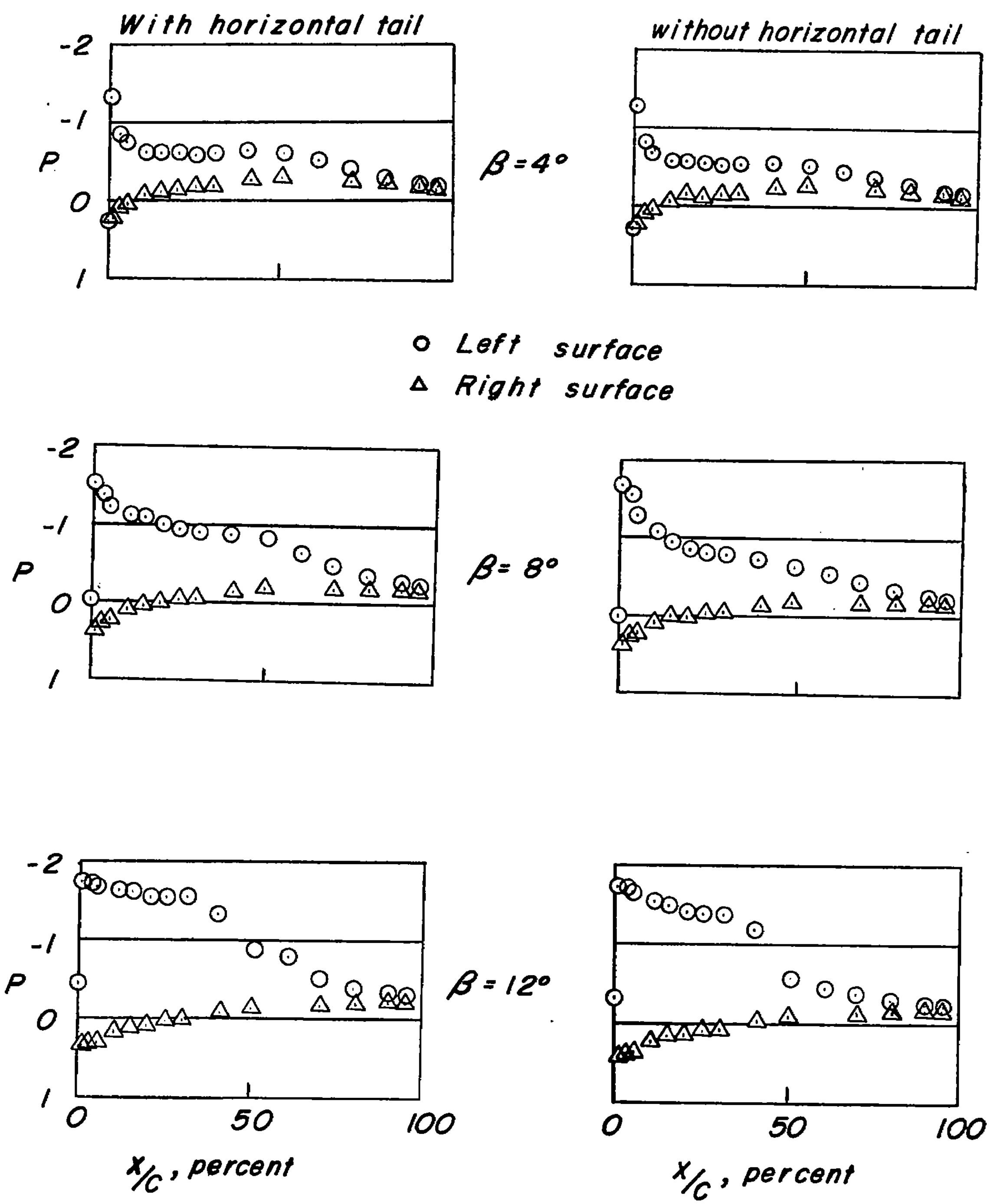
(a) $\alpha = 0^{\circ}$.

Figure 20.- Pressure distribution on vertical tail. Station $0.450b_v$; $M = 0.85$.



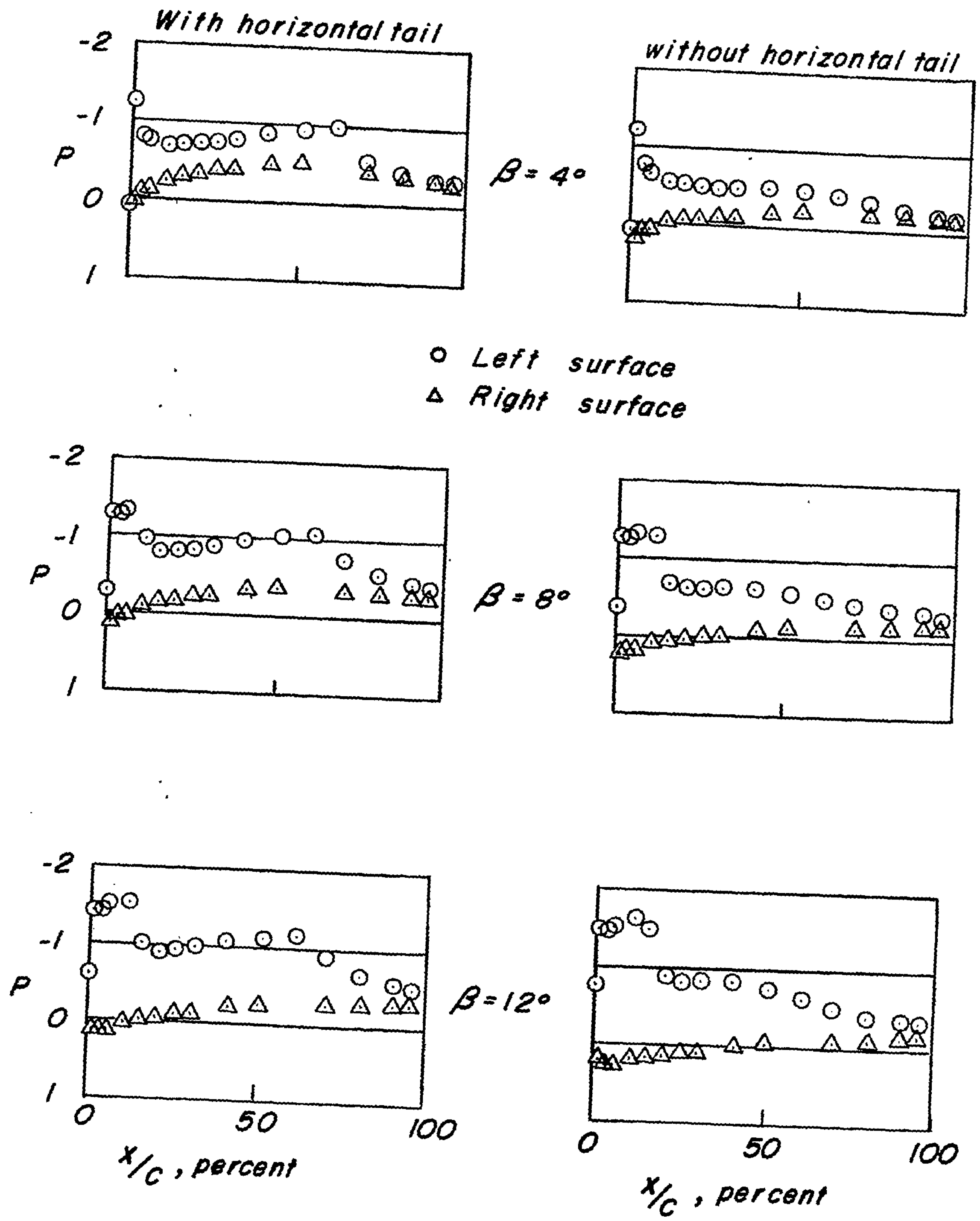
(b) $\alpha = 12^{\circ}$.

Figure 20.- Concluded.



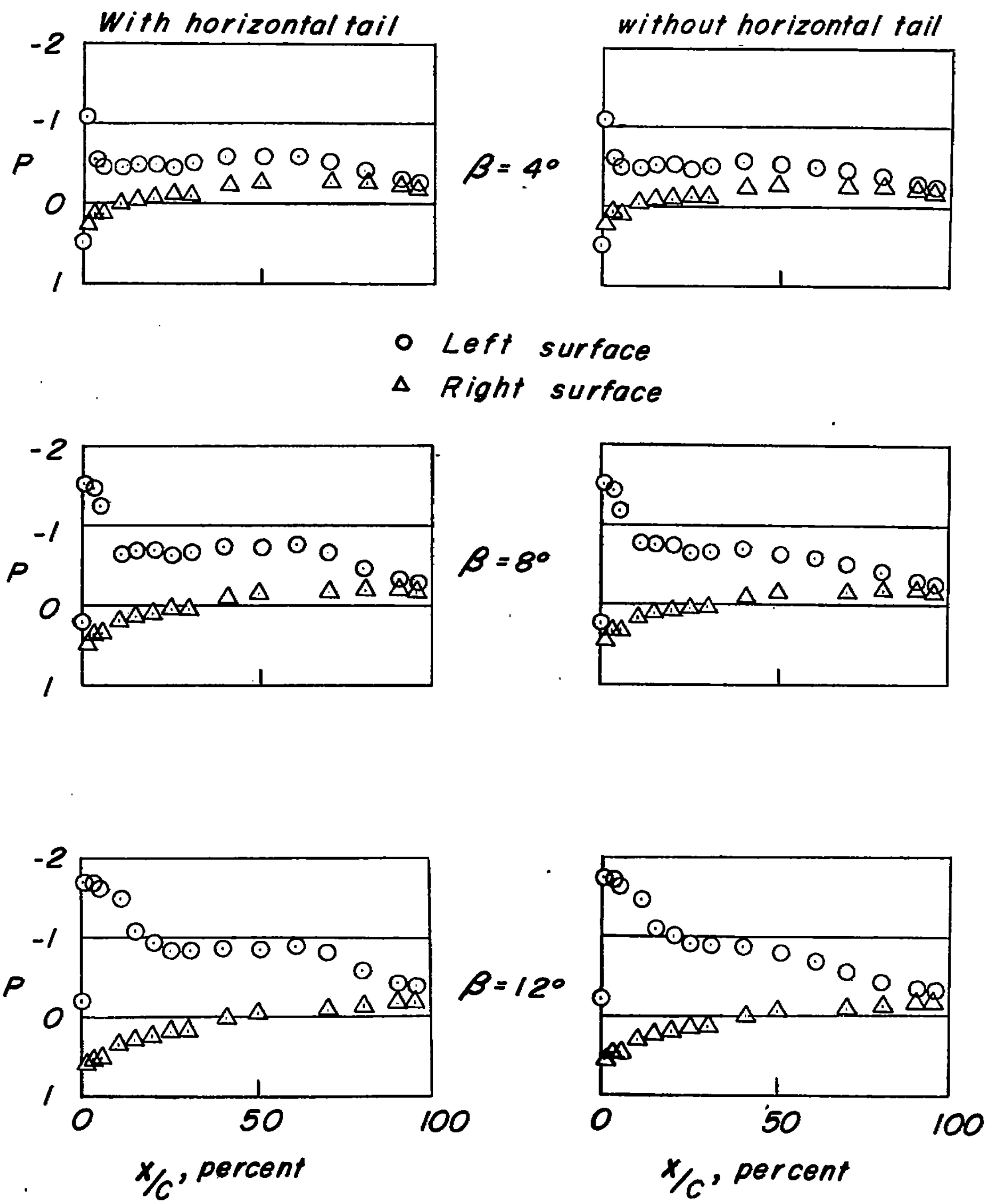
(a) $\alpha = 0^{\circ}$.

Figure 21.- Pressure distribution on vertical tail. Station $0.300b_v$; $M = 0.85$.



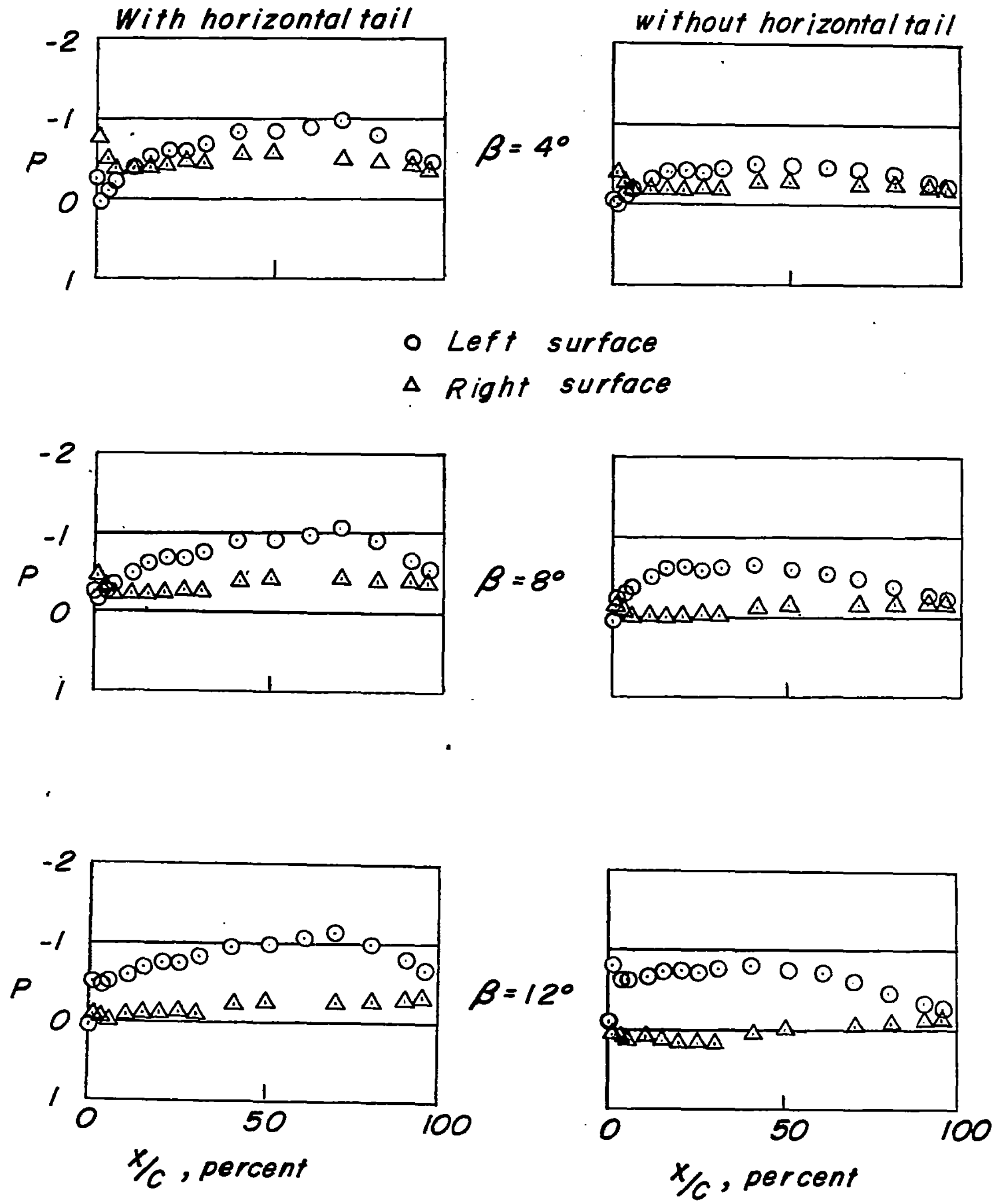
(b) $\alpha = 12^{\circ}$.

Figure 21.- Concluded.



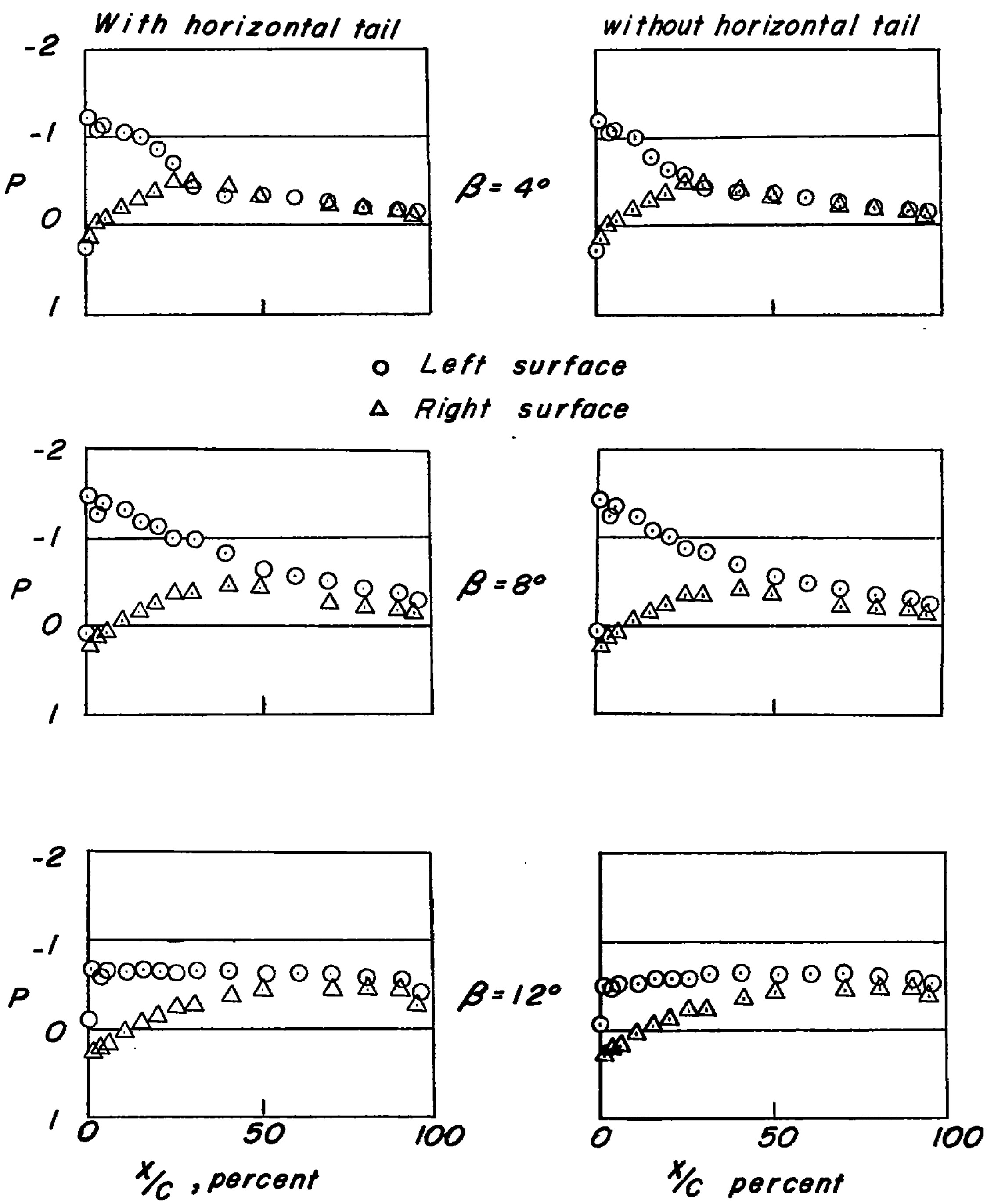
(a) $\alpha = 0^{\circ}$.

Figure 22.- Pressure distribution on vertical tail. Station $0.200b_v$; $M = 0.85$.



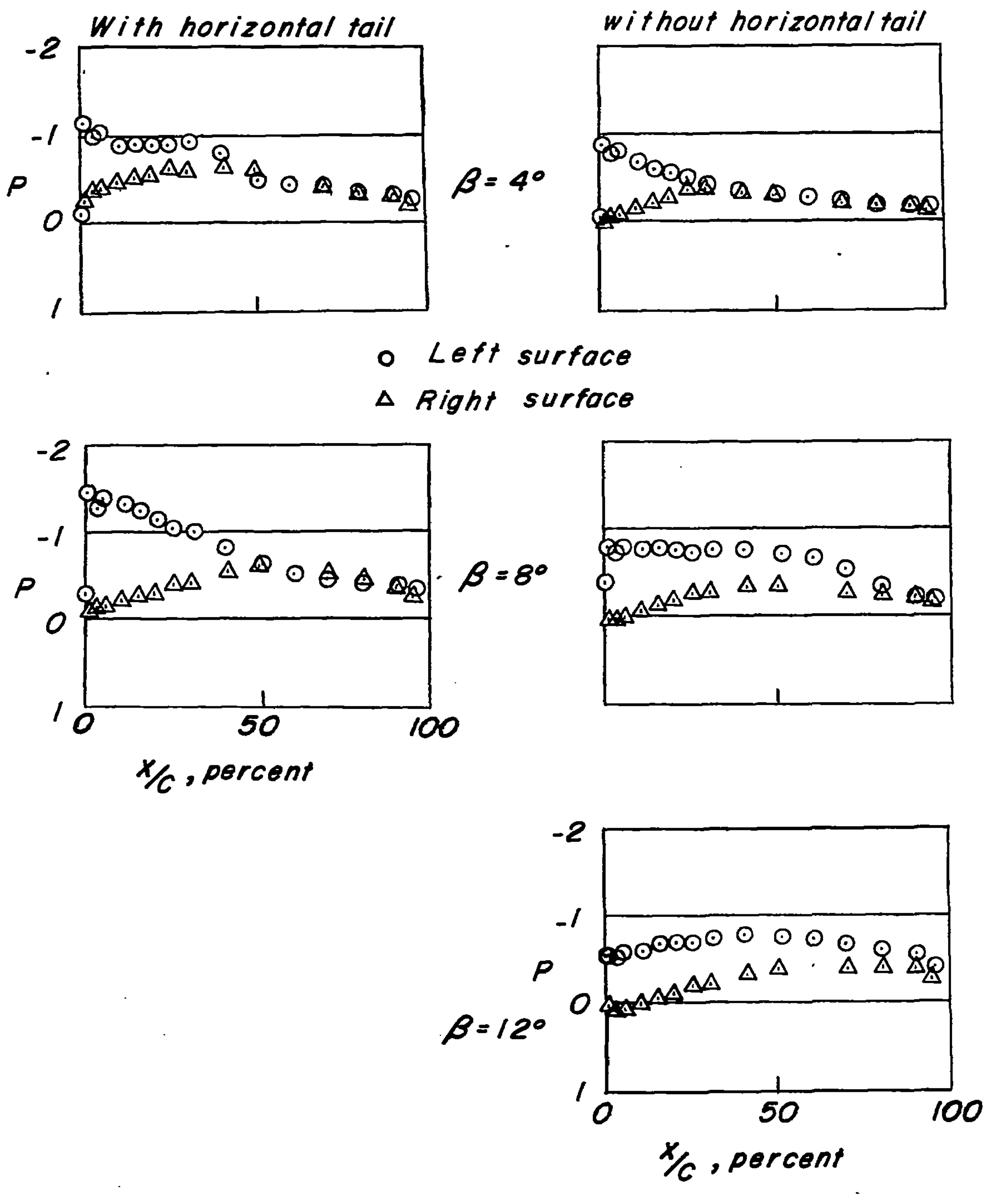
(b) $\alpha = 12^{\circ}$.

Figure 22.- Concluded.



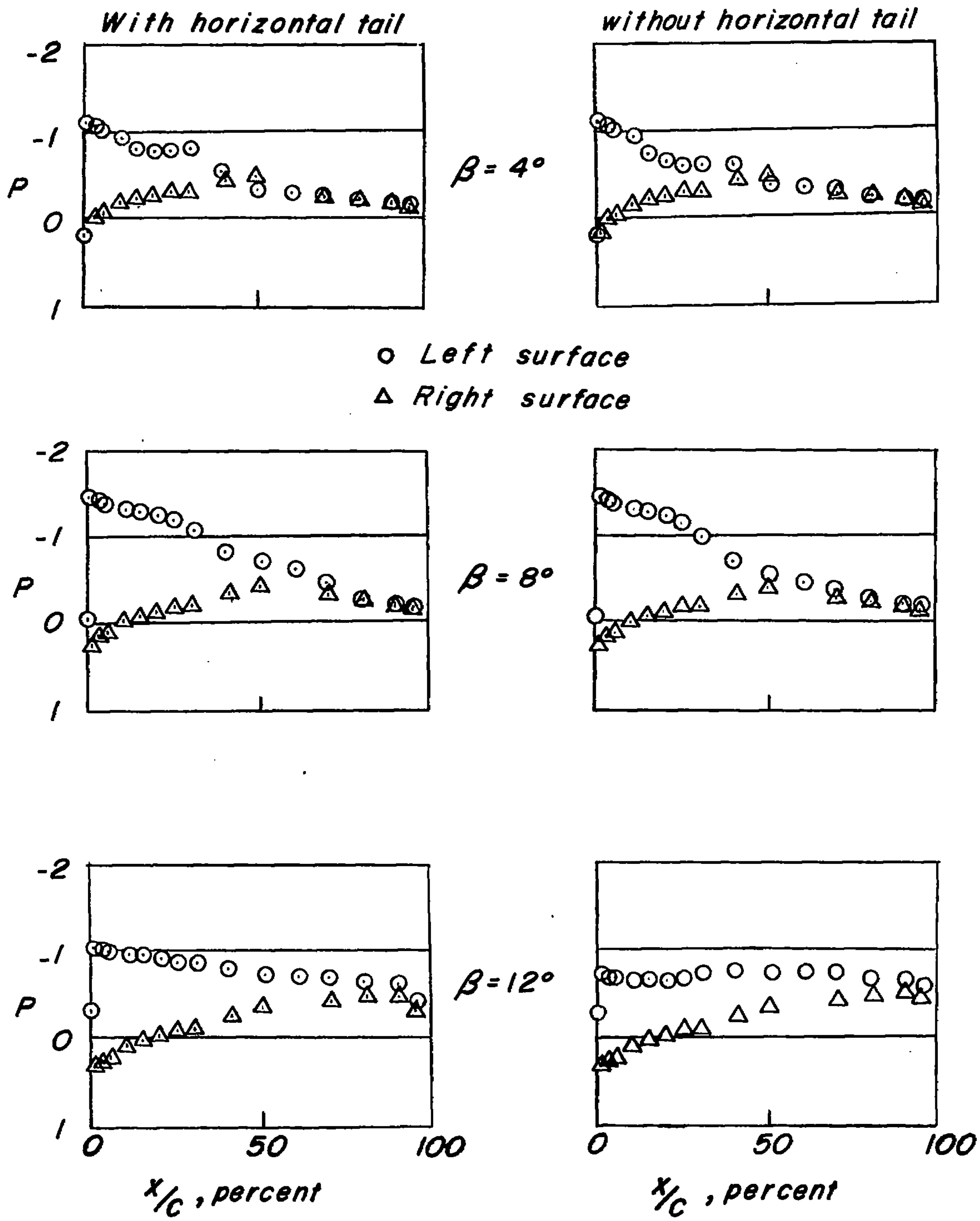
(a) $\alpha = 0^{\circ}$.

Figure 23.- Pressure distribution on vertical tail. Station $0.931b_v$; $M = 0.95$.



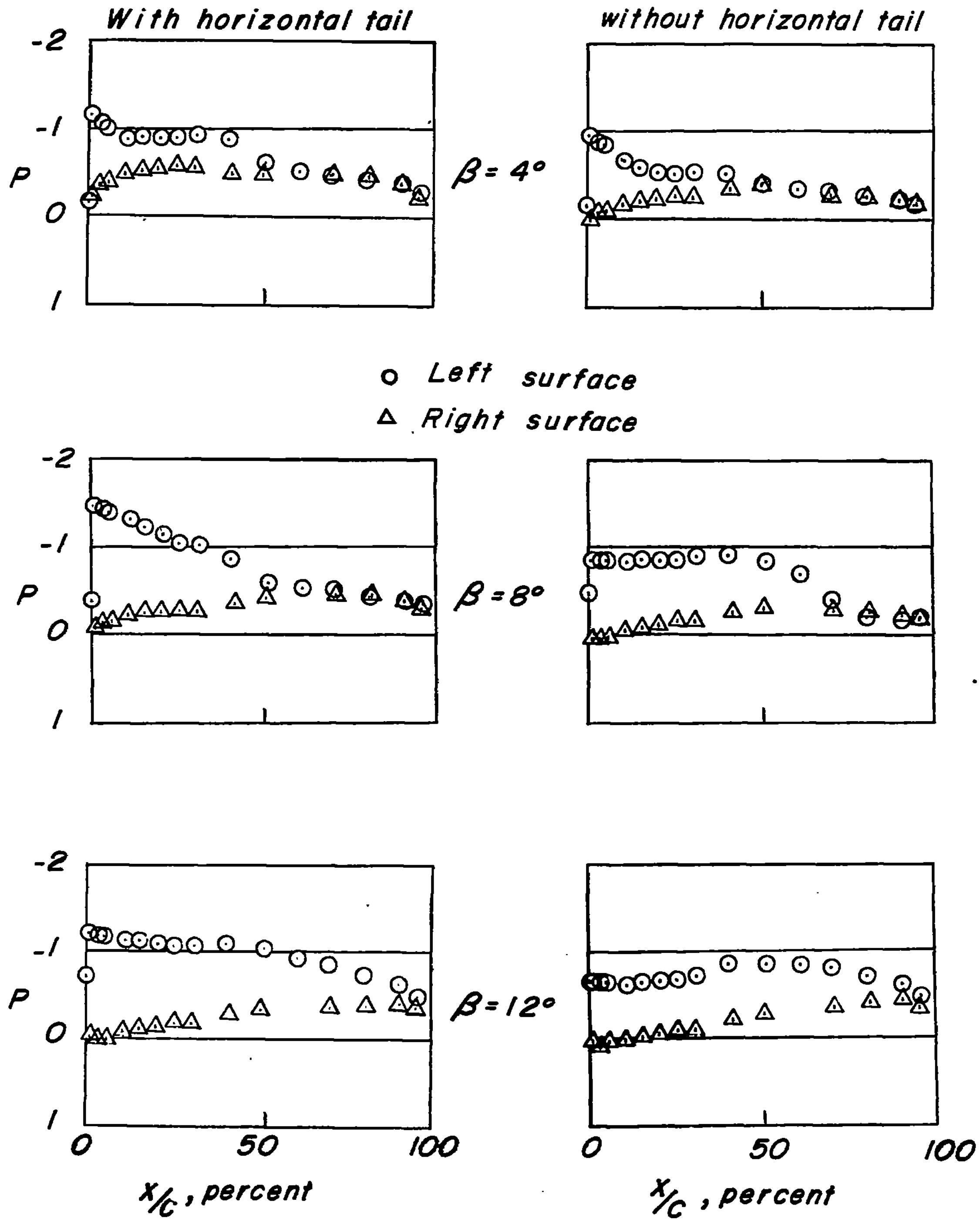
(b) $\alpha = 12^{\circ}$.

Figure 23.- Concluded.



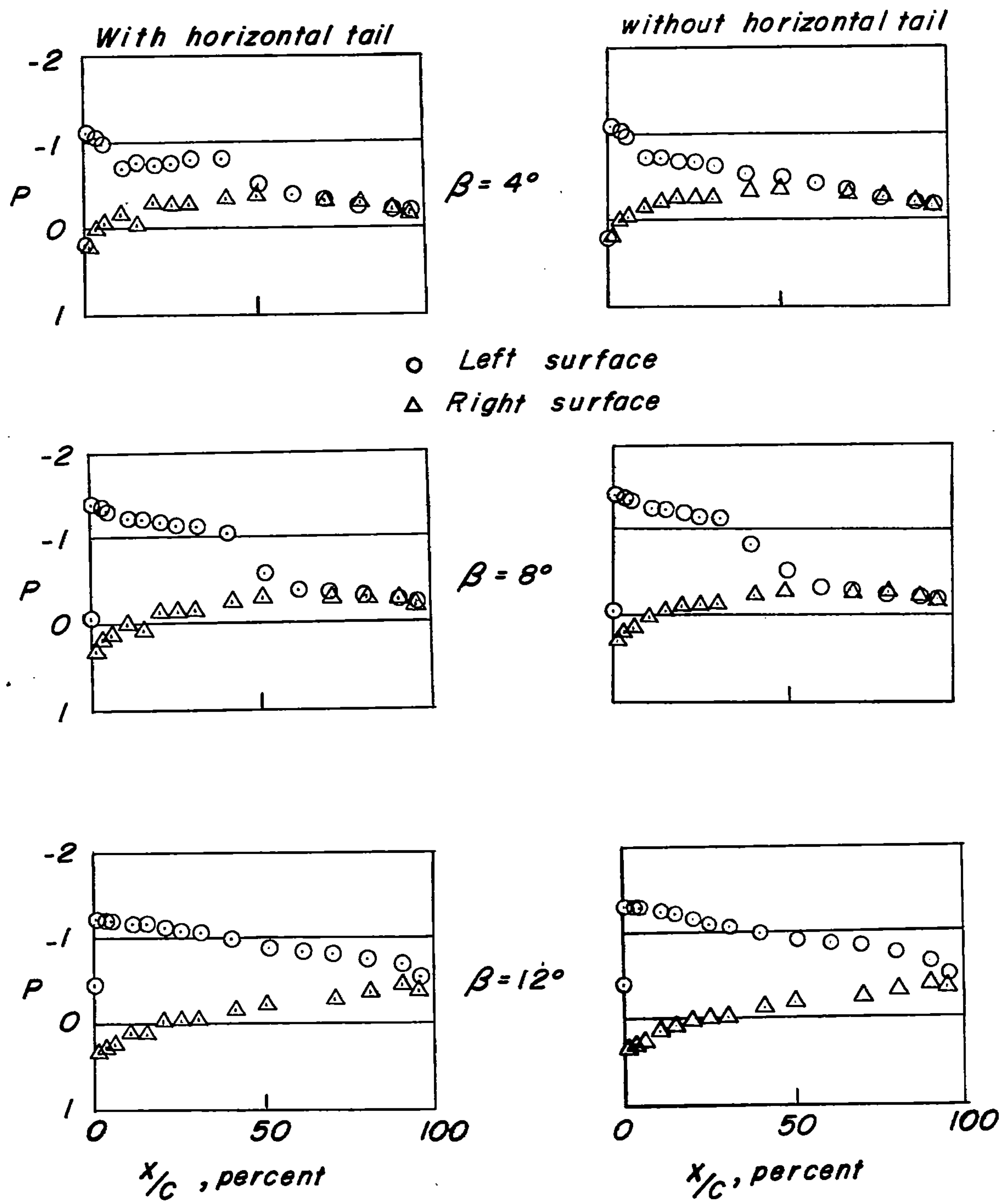
(a) $\alpha = 0^{\circ}$.

Figure 24.- Pressure distribution on vertical tail. Station $0.850b_v$; $M = 0.95$.



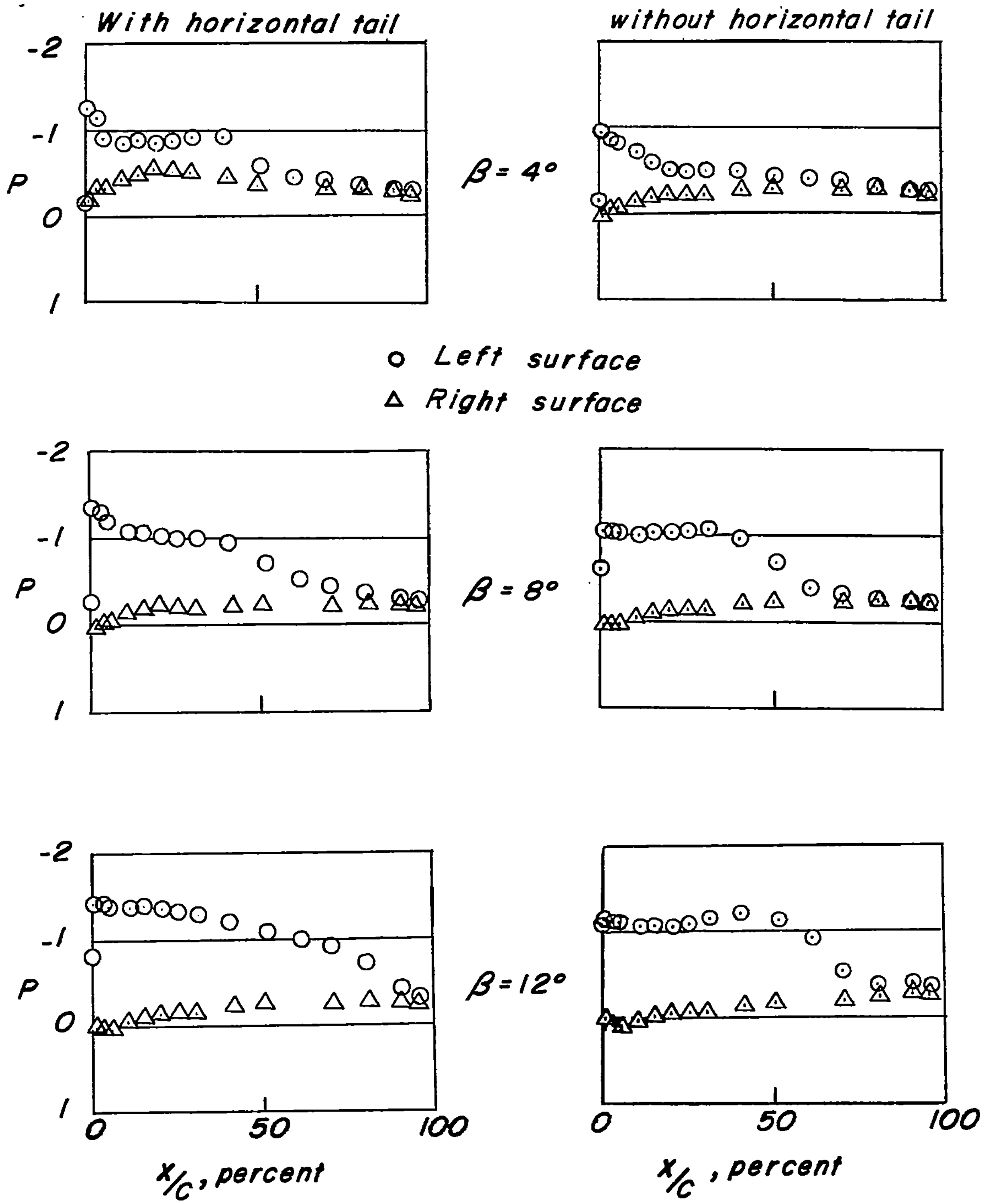
(b) $\alpha = 12^{\circ}$.

Figure 24.- Concluded.



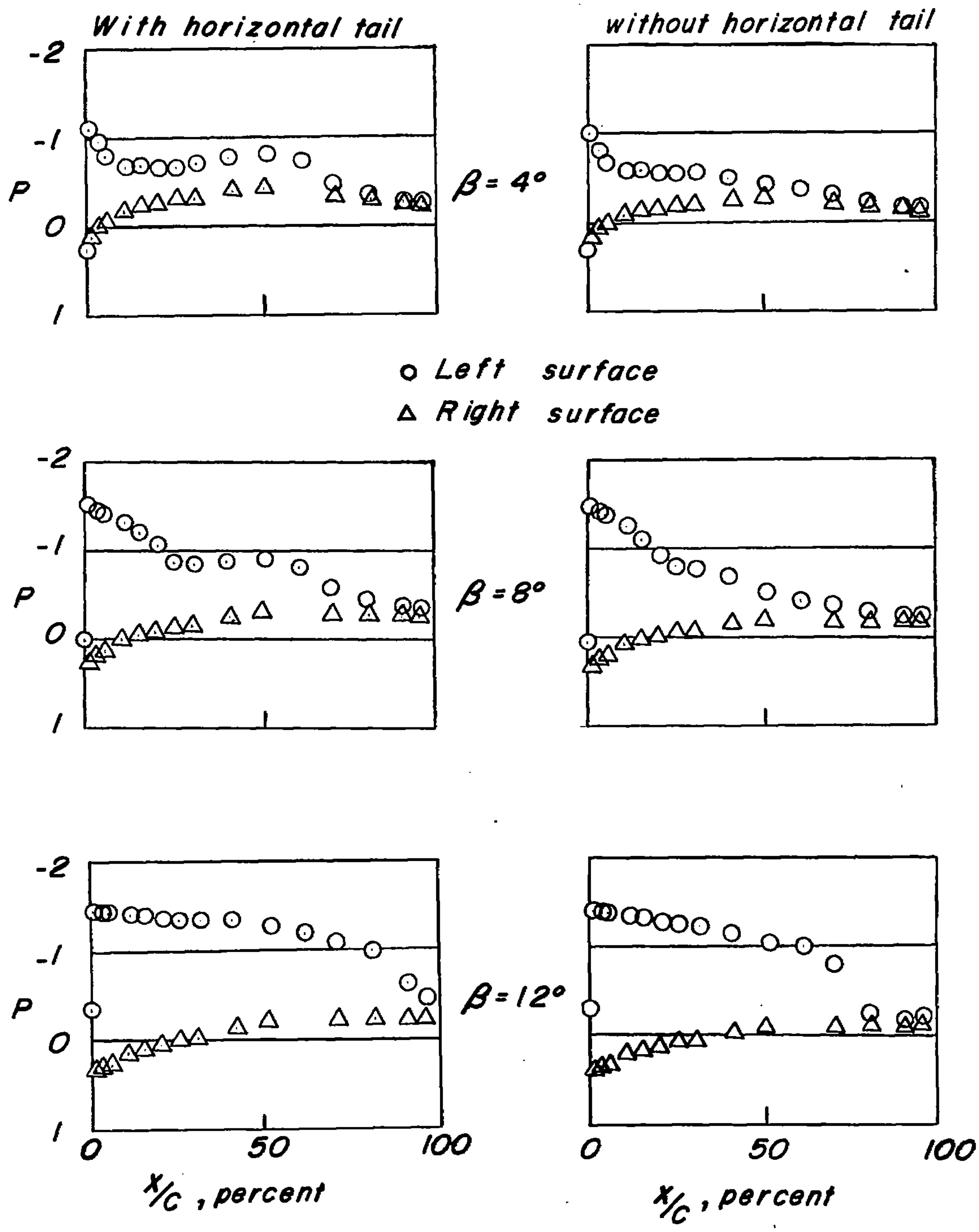
(a) $\alpha = 0^{\circ}$.

Figure 25.- Pressure distribution on vertical tail. Station $0.700b_v$; $M = 0.95$.



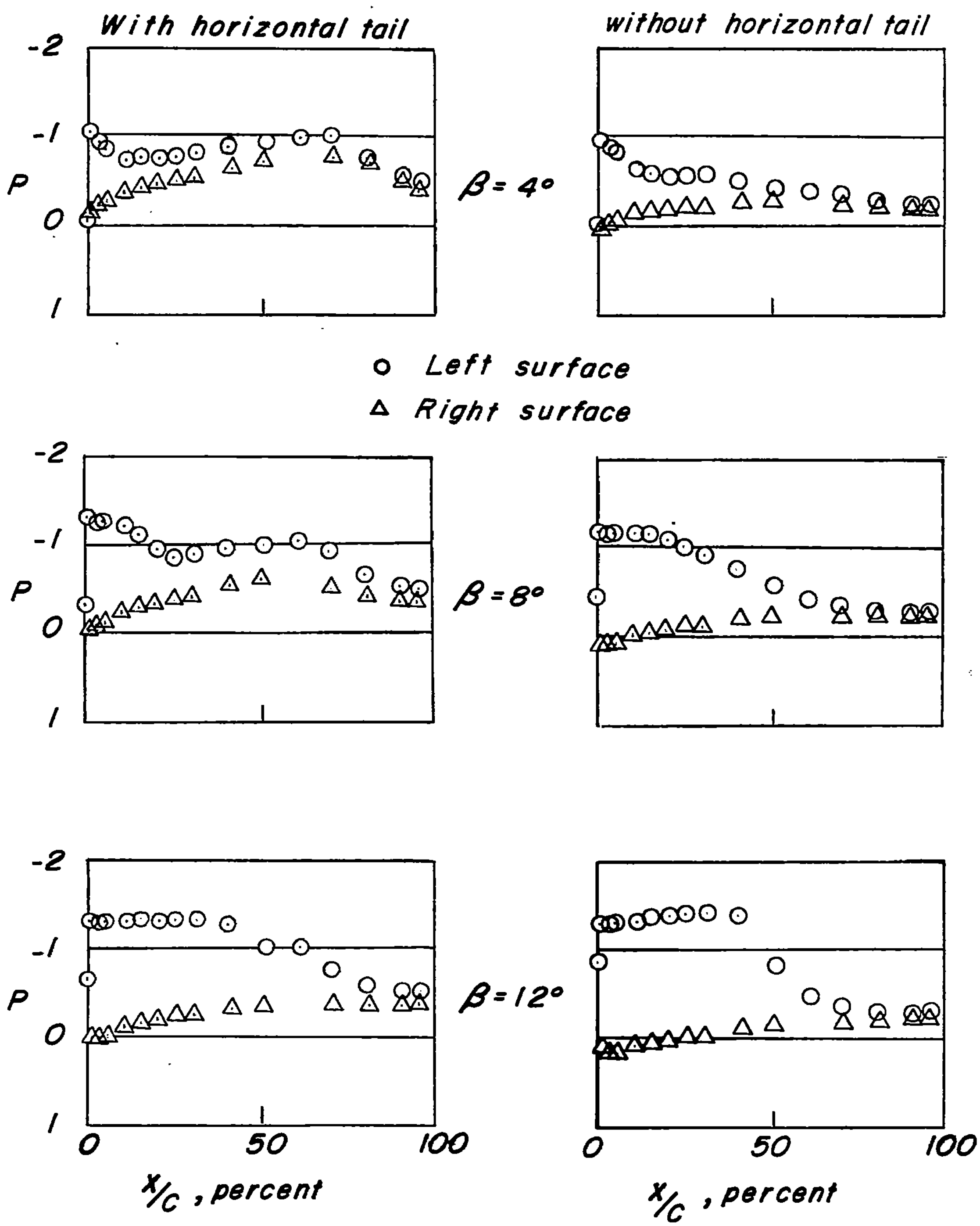
(b) $\alpha = 12^{\circ}$.

Figure 25.- Concluded.



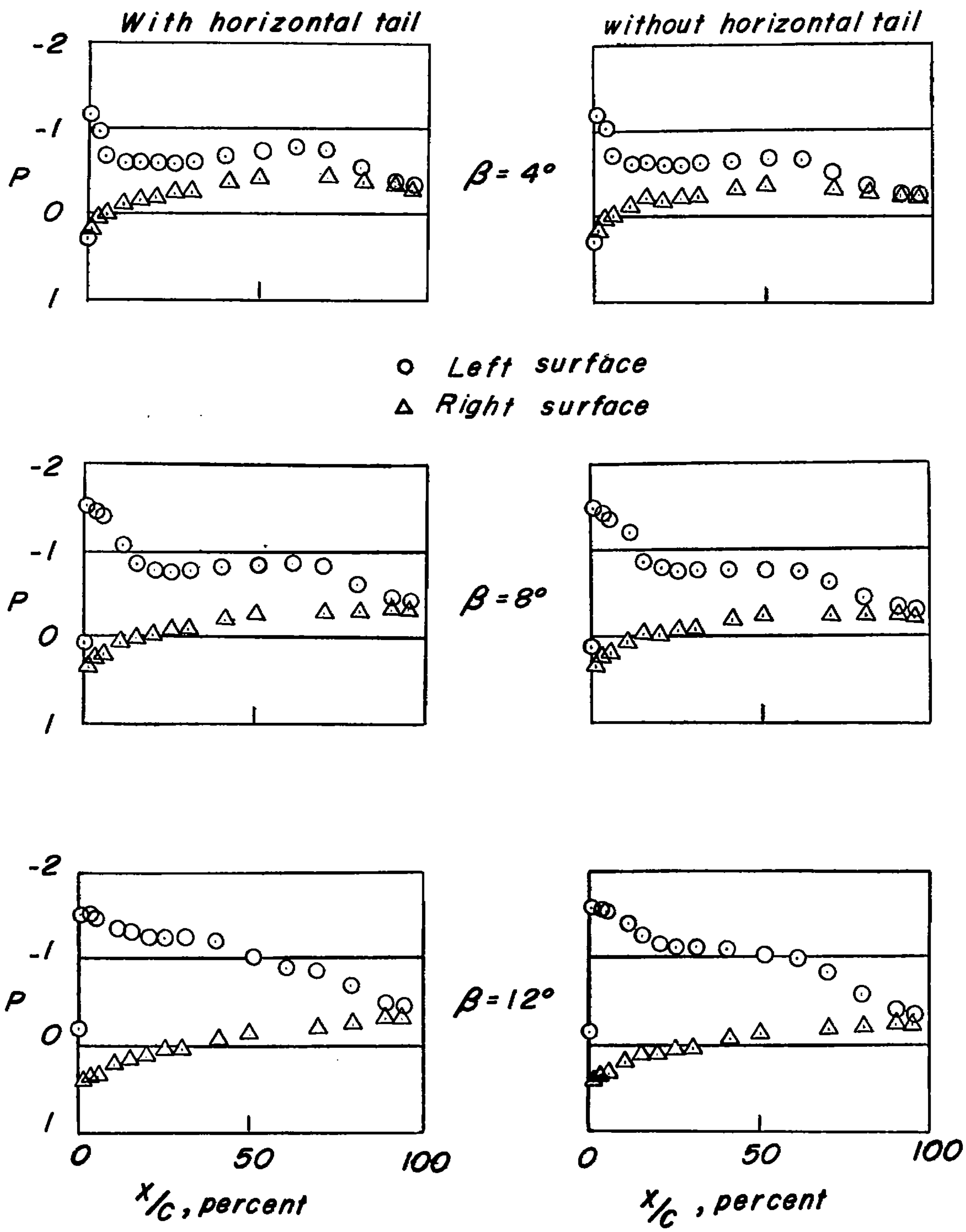
(a) $\alpha = 0^{\circ}$.

Figure 26.- Pressure distribution on vertical tail. Station $0.450b_v$; $M = 0.95$.



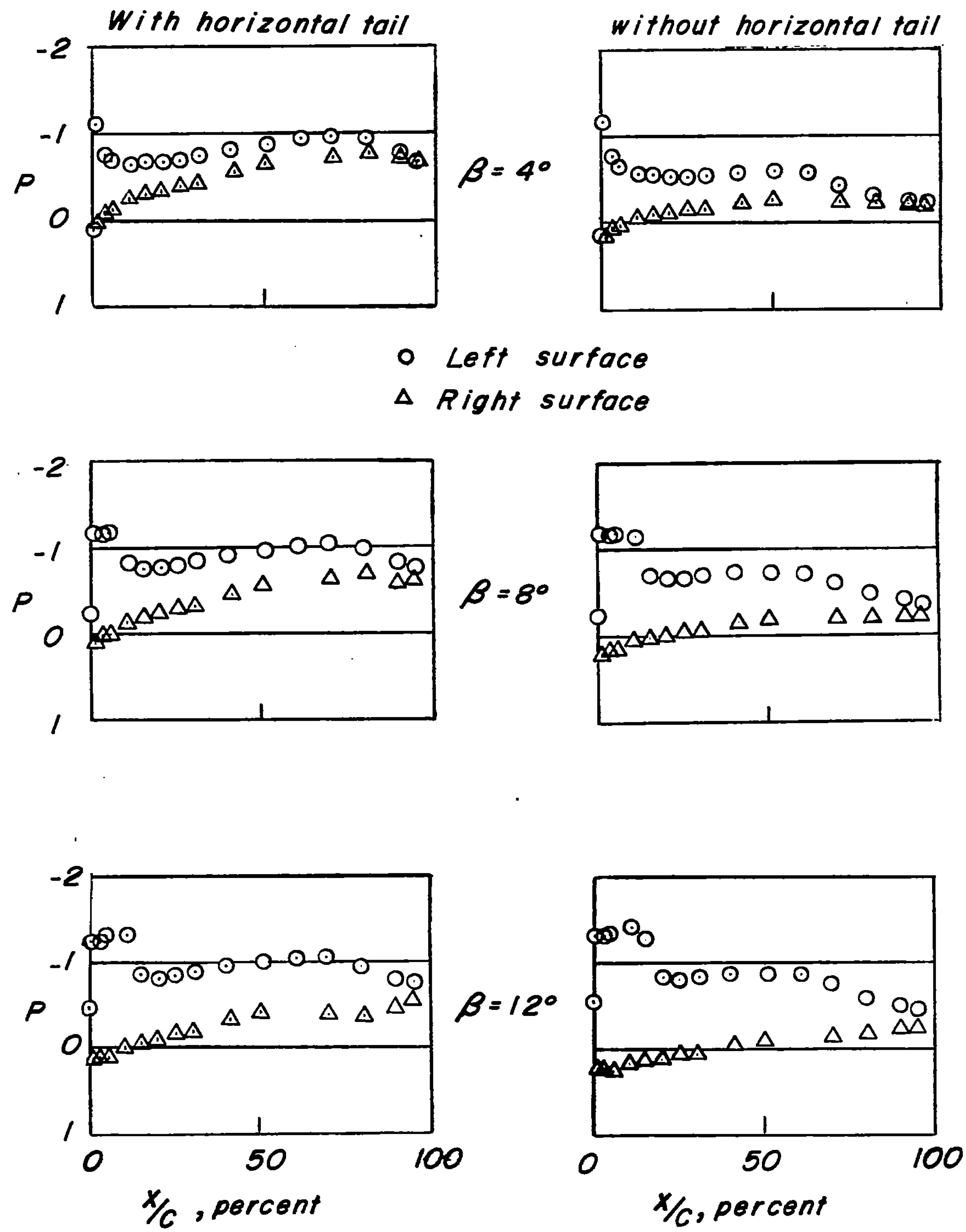
(b) $\alpha = 12^{\circ}$.

Figure 26.- Concluded.



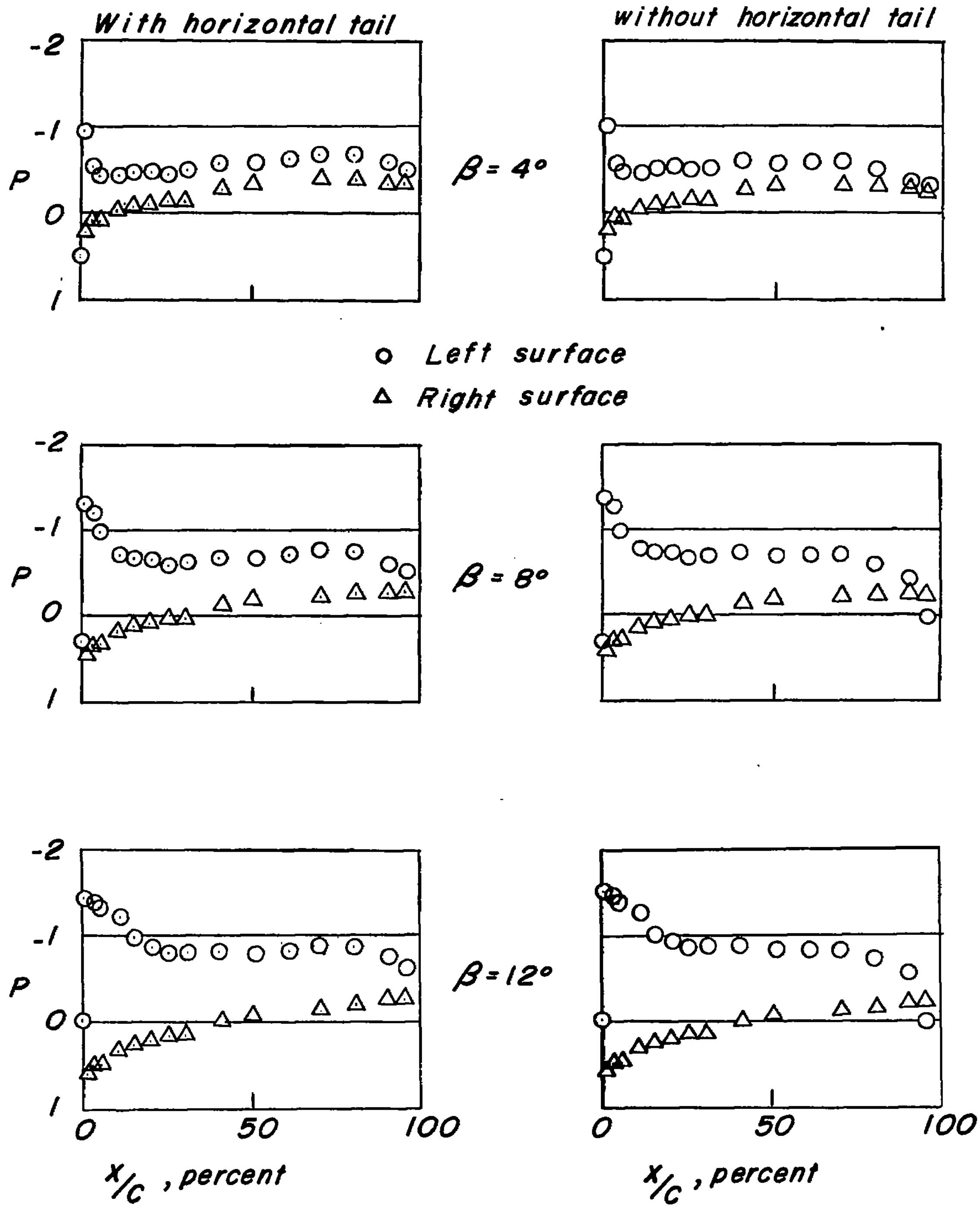
(a) $\alpha = 0^{\circ}$.

Figure 27.- Pressure distribution on vertical tail. Station $0.300b_v$; $M = 0.95$.



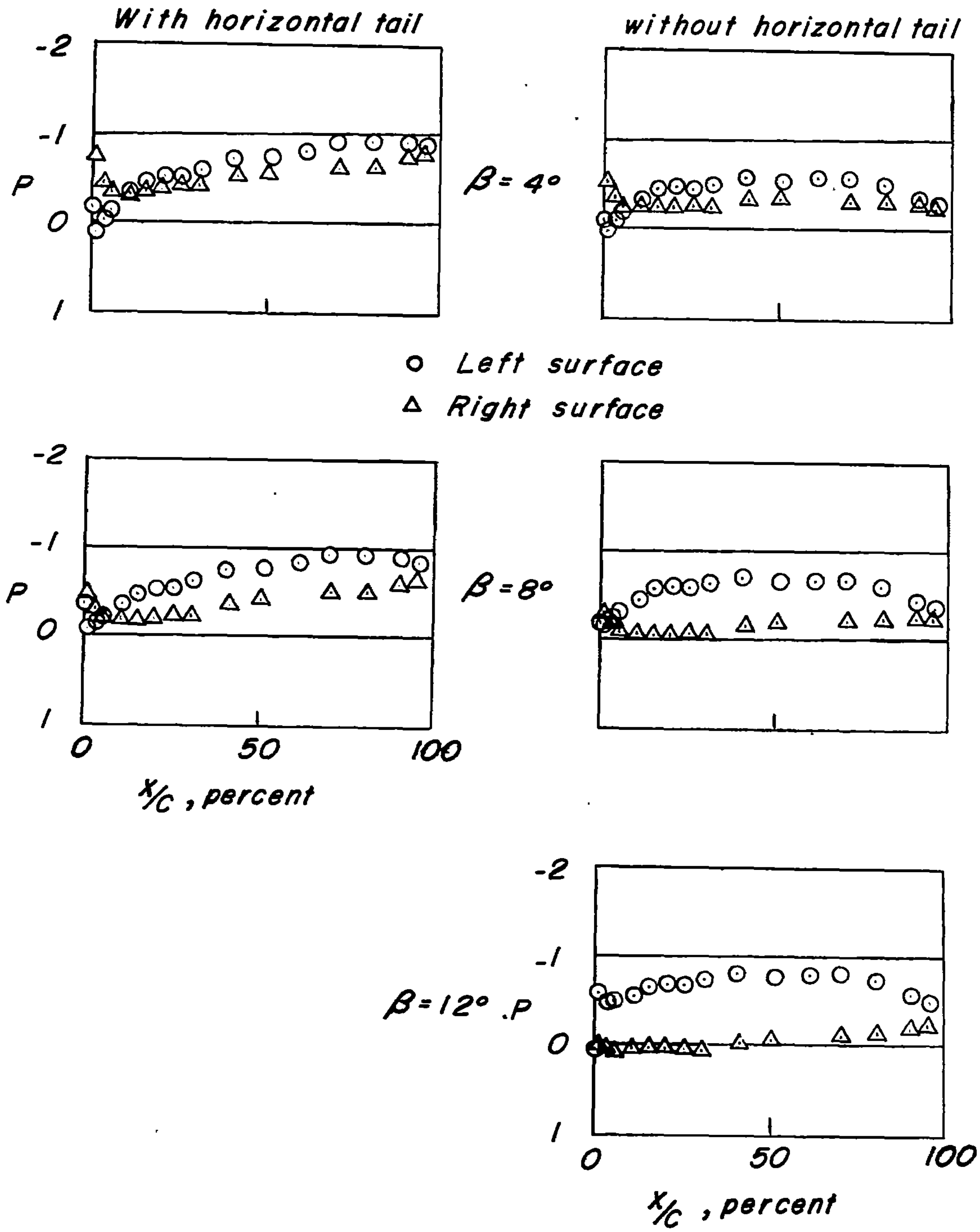
(b) $\alpha = 12^{\circ}$.

Figure 27.- Concluded.



(a) $\alpha = 0^{\circ}$.

Figure 28.- Pressure distribution on vertical tail. Station $0.200b_v$; $M = 0.95$.



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

Figure 28.- Concluded.