NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

TECHNICAL MEMORANDUM

No. 1129

TEST REPORT ON MEASUREMENTS ON A SERIES OF TAPERED WINGS OF SMALL ASPECT RATIO

(Trapezoidal Wing with Fuselage)

By Lange/Wacke

Translation

"Prüfbericht über 3- und 6-Komponentenmessung an der Zuspitzungsreihe von Flügeln kleiner Streckung. Teilbericht: Trapezflügel mit Rumpf"

Deutsche Luftfahrtforschung, Untersuchungen und Mitteilungen Nr. 1023/2

Washington
July 1947

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

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(Trapezoidal Wing with Fuselage)

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This is the second of a series of six reports dealing with three- and six-component measurements on the tapering series at small aspect ratio. The present report concerns the trapezoidal wing with fuselage (fig. 2).

The Wings of the First Test Series with Fitted Fuselage

To enable an accurate comparison between the measurements on the wing alone and those on the wing with fuselage, the tests of both series were carried on under identical conditions. The method of comparison on the six-component balance is illustrated in figure 3. The preliminary tension was again located centrally as on the wing alone. The tests were made in the 3 × 2.15m DVL wind tunnel. The dynamic pressure was $q = 100 \text{ kg/m}^2$, which is equivalent to an airspeed of 40 m/s.

The forces and moments were defined by the standard DIN L 100 and measured in the experimental system of axes (fig. 7). The moment reference point for all three wings lies on the wing chord at distance of three-fourths of mean reference chord of the wing trailing edge (fig. 2). The reference axes for the moments are defined as follows:

Rolling moment: x_e-axis = line of intersection of the vertical plane of symmetry of the body with the horizontal plane of the tunnel (positive in flow direction)

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*"Prüfbericht über 3- und 6- Komponentenmessung an der Zuspitzungsreihe von Flügeln kleiner Streckung, Teilbericht: Trapezflügel mit Rumpf." Untersuchungen und Mitteilungen Nr. 1023/2. Zentrale für wissenschaftliches Berichtswesen der Luftfahrtforschung des Generalluftzeugmeisters (ZWB) Berlin-Adlershof, Sept. 17, 1943.

Pitching moment: y_e-axis = transverse axis along the wings (positive when seen in flow direction toward the left).

Yawing moment: z_e-axis = normal axis in wind direction (positive downward).

All moments seen along positive axes of rotation at clockwise rotation are positive.

The force and moment coefficients are:

A lift (kg)

W drag (kg)

Q transverse force (kg)

L rolling moment (mkg)

M pitching moment (mkg)

N yawing moment (mkg)

$c_a = \frac{A}{q \times F}$ lift coefficient

$c_w = \frac{W}{q \times F}$ drag coefficient

$c_q = \frac{Q}{q \times F}$ cross-wind force coefficient

$c_L = \frac{L}{q \times F \times \frac{b}{2}}$ rolling-moment coefficient

$c_M = \frac{M}{q \times F \times l_m}$ pitching-moment coefficient

$c_N = \frac{N}{q \times F \times \frac{b}{2}}$ yawing-moment coefficient

Reference quantities:

$F = 0.75(m^2)$ = Wing area

$b = 1$ (m) = Span

$l_m = \frac{F}{b} = 0.75$ (m) = Mean wing chord (reference chord)

$q = \frac{\rho}{2} v^2 = 100$ (kg/m^2) = Dynamic Pressure

Angles:

α = Angle of attack	angle between longitudinal axis along the wing and the x_e-axis at rotation about the y_e-axis.
β = Angle of yaw	angle between the longitudinal axis in wind direction and the x_e-axis at rotation about the z_e-axis, viewed along the positive axes of rotation for clockwise movement the prefixes are positive.

The respective curves and tables are listed in table A.

(a) Three-component measurements.- The coefficients of the three models are reproduced in graphs 1, 7, and 13 as $c_a = f(\alpha)$, $c_a = f(c_W)$, and $c_a = f(c_M)$. A comparison with the data for the wing alone indicates that the added fuselage causes no fundamental changes in the forces and movements with respect to the angle of attack. Increasing taper, especially in the upper angle-of-attack range, is accompanied by a marked decrease in c_a'.

The drag increase with increasing taper, starting at $\alpha = 18^\circ$, is also noted, but no expressed drag increase due to the fuselage is observed. While the $c_{a_{max}}$ at $\Lambda = \frac{1}{4}$ and $\frac{1}{8}$ differs from that of the wing alone very little, it increases from 1.2 to 1.26 at $\Lambda = \frac{1}{2}$ in the presence of the fuselage. The cause is likely to be found in the lift portion of the projecting fuselage, which lies in the up wind zone of the wing. At $\Lambda = \frac{1}{4}$ and $\Lambda = \frac{1}{8}$ this does not occur, since the nose does not project as much.

The neutral-point position at $c_a = 0$ moves backward with increasing taper in the same way as on the wing alone. The overhanging fuselage nose causes the neutral point to move forward, as expected. It is relatively greatest on the model DT 1/2, where the fuselage extends farthest beyond the leading edge. At $c_a = 0.3$ the neutral point moves considerably backward, as for the wing alone. Static stability is reached. This is attributable to a lift-producing transverse flow in the rear part of the wing according to stream measurements at the triangular wing.

(b) Six-component measurements.- Lift and drag are nearly independent of the yawed flow. The marked drop in c_a observed at high angles of attack is considerably reduced by the presence of the fuselage since the fuselage prevents the flow-off of the boundary layer along the span.

At small angles of attack the taper has little effect on the transverse force. The principal portion of the transverse force comes from the fuselage, so that $\frac{dc_q}{d\beta}$ is increased substantially for the wing-fuselage combination. However, at $\alpha > 16^\circ$ this portion is secondary to the transverse force of the wing. The transverse force changes signs and $\frac{dc_q}{d\beta}$ becomes negative.

The effect of the fuselage on the rolling moments is unimportant. An increase in taper is accompanied by an increase in $\frac{dc_L}{d\beta}$.

The effect of the fuselage on the pitching moment with respect to β is zero compared to the wing alone.

At small angles of attack, the yawing moment with respect to β is essentially determined by the fuselage. The relationship with the taper observed on the wing alone does not appear. Starting at $\alpha > 16^\circ$ an increasing instability is observed with increasing taper.

FURTHER REPORTS OF THE SERIES

	UM NO.
Trapezoidal wing ($\Lambda = 4/3$)	1023/1
Elliptic wing ($\Lambda = 2 + 1$)	1023/3
Elliptic wing and fuselage	1023/4
Triangular wing ($\Lambda = 3 + 1$)	1023/5
Triangular wing and fuselage	1023/6

Translated by J. Vanier
National Advisory Committee
for Aeronautics

TABLE A

SURVEY OF THE THREE- AND SIX-COMPONENT MEASUREMENTS ON THE SERIES OF TAPERED WING (TRAPEZOID WITH FUSELAGE)

Symbol	Angle α^o	Angle β^o	Chart of curves	Table
DT 1/2 Three-component measurement	Variable	0	1	1
DT 1/2 Six-component measurement	0	Variable	2	2
Do----	9.0	---do---	3	2
Do----	16.45	---do---	4	3
Do----	23.08	---do---	5	3
Do----	32.30	---do---	6	4
DT 1/4 Three-component measurement	Variable	0	7	5
DT 1/4 Six-component measurement	0	Variable	8	6
Do----	9.63	---do---	9	6
Do----	17.65	---do---	10	7
Do----	23.74	---do---	11	7
Do----	37.50	---do---	12	8
DT 1/8 Three-component measurement	Variable	0	13	9
DT 1/8 Six-component measurement	0	Variable	14	10
Do----	10.30	---do---	15	10
Do----	19.04	---do---	16	11
Do----	27.38	---do---	17	11
Do----	38.57	---do---	18	12
Comparative curves of the three models				
$c_a = f(\alpha)$; $c_a = f(c_w)$	Variable	0	19	
$c_a = f(c_M)$	Variable	0	20	
c_L and $c_q = f(\beta)$	$\alpha_{c_a} = 0.3$	Variable	21	
c_L and $c_q = f(\beta)$	$\alpha_{c_a} = 0.9$	Variable	22	

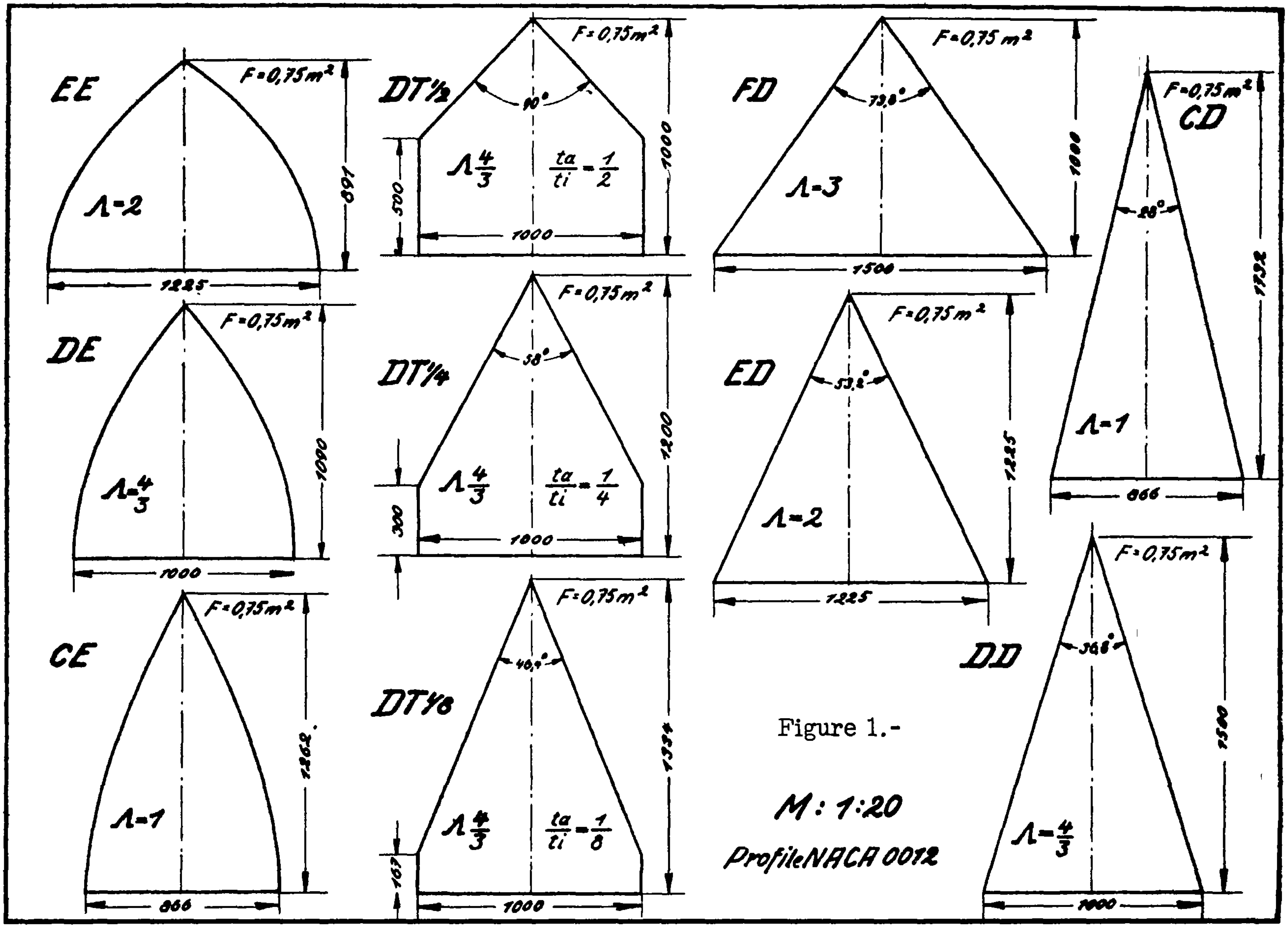
EE
F=0,75m²
Λ=2
891
1225
DT½
F=0,75m²
90°
Λ 4/3
ta/ti = 1/2
500
1000
1000
FD
F=0,75 m²
73,8°
Λ=3
1000
1500
CD
F=0,75m²
28°
Λ=1
1732
866
DE
F=0,75m²
Λ=4/3
1000
1000
DT¼
F=0,75m²
58°
Λ 4/3
ta/ti = 1/4
300
1000
1200
ED
F=0,75m²
53,2°
Λ=2
1225
1225
CE
F=0,75m²
Λ=1
1262
866
DT⅛
F=0,75m²
40,4°
Λ 4/3
ta/ti = 1/8
167
1000
1334
DD
F=0,75m²
36,8°
Λ=4/3
1500
1000
M: 1:20
Profile NACA 0012

Figure 1.-

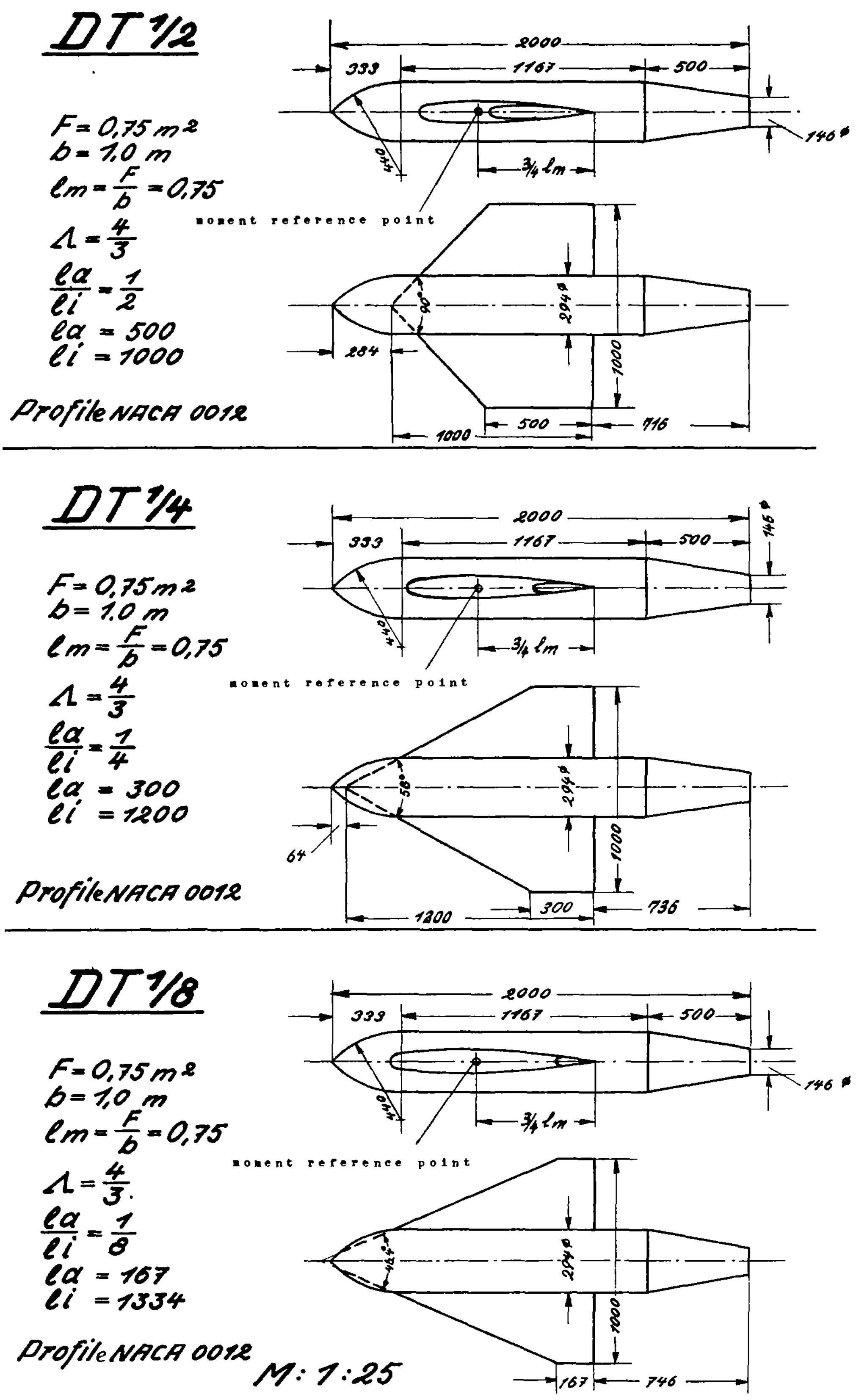

Figure 2.- Series of tapered wings - Trapezoidal wing with fuselage.

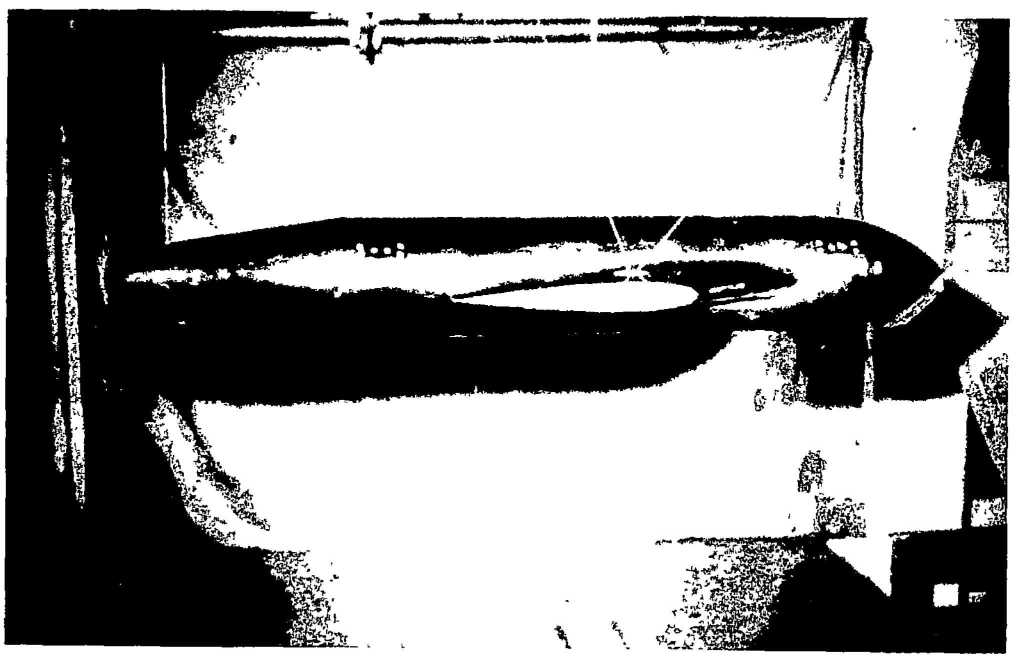

Figure 3.- Suspension of a model in 3 × 2.15m wind tunnel.

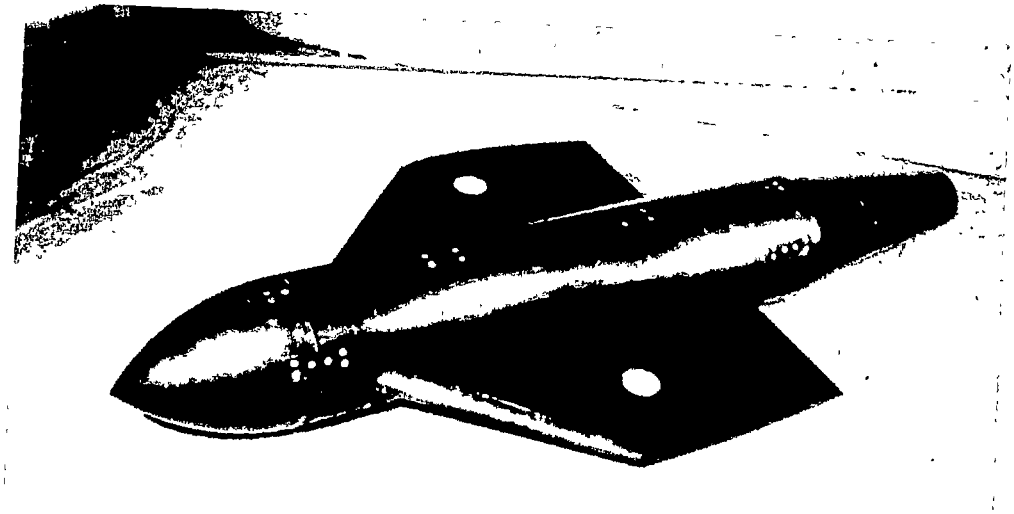

Figure 4.- DT 1/2

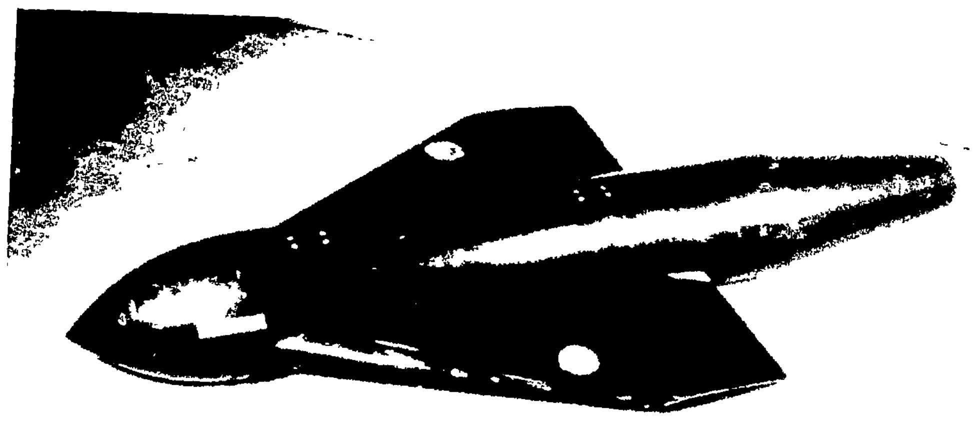

Figure 5.- DT 1/4

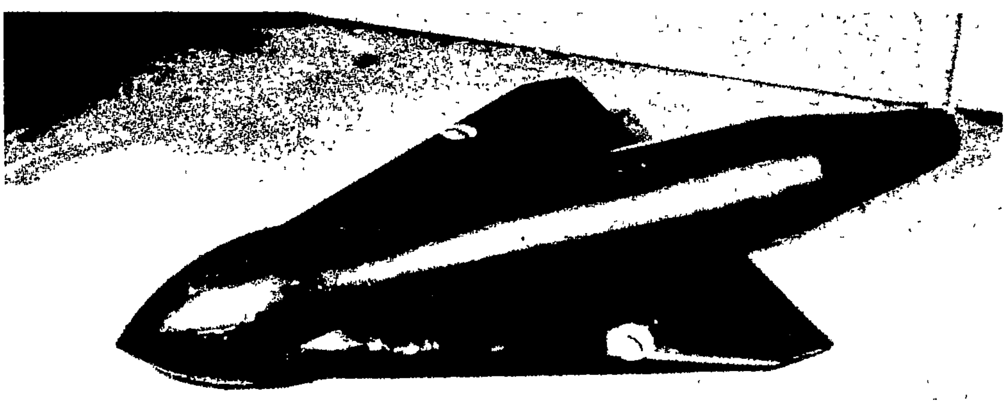

Figure 6.- DT 1/8

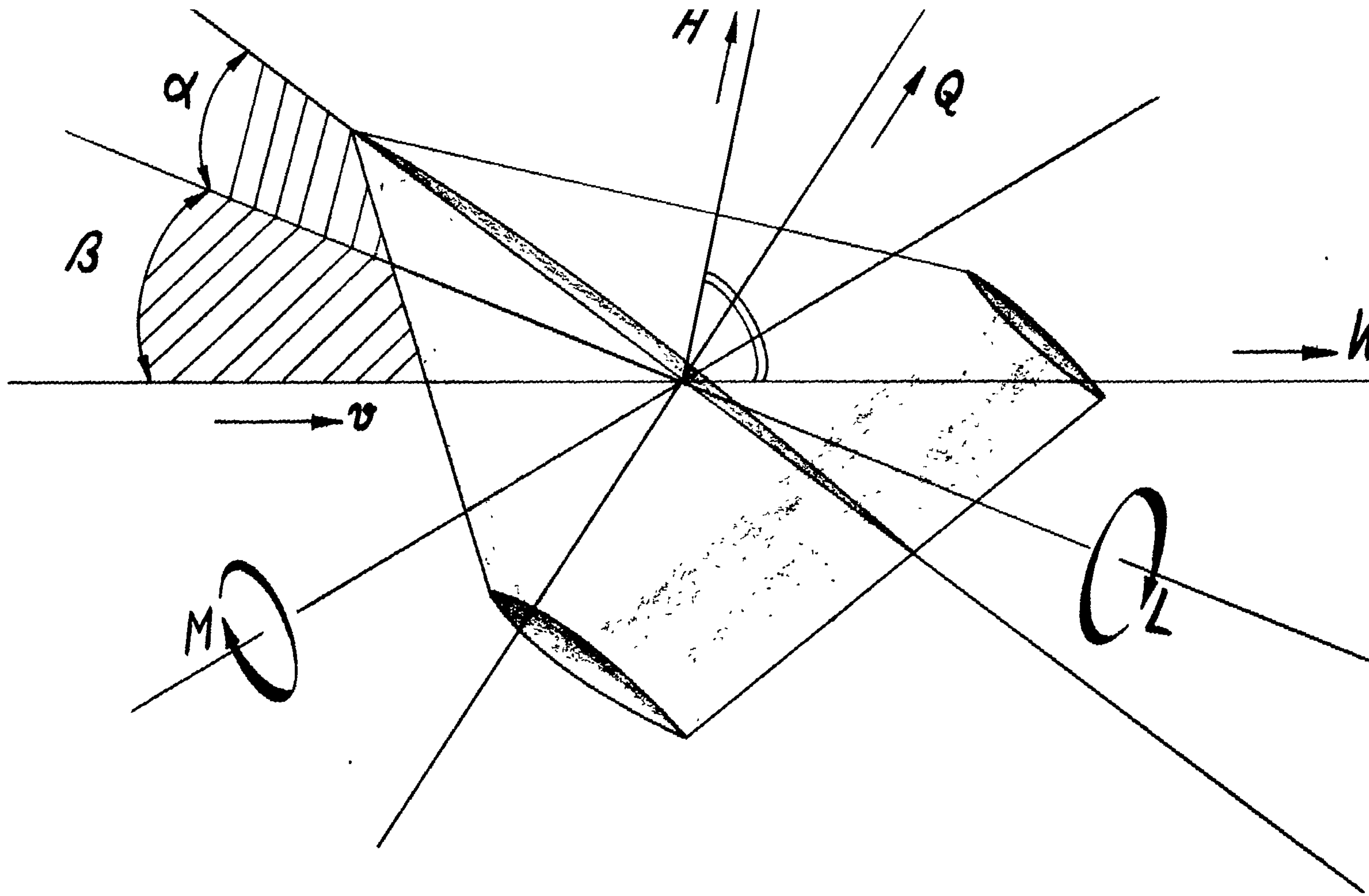

Figure 7.- Coordinate system of the 6-component measurement.

THREE-COMPONENT MEASUREMENTS OF A SERIES OF TAPERED WINGS
(Trapezoid Wing with Fuselage)
TABLE NO. 1 TO CHART 1
DT 1/2 with Fuselage

α^o	c_a	c_w	c_M
-5.78	-0.161	0.0220	-0.0288
0	0	.0123	-.0008
5.77	.179	.0220	.0224
11.51	.384	.0561	.0295
17.20	.609	.1193	.0215
22.88	.854	.2237	-.0028
28.55	1.097	.3703	-.0329
31.42	1.194	.5477	-.0759
31.38	1.224	.5682	-.0780
32.33	1.258	.6130	-.0906
33.41	1.186	.6914	-.1037
34.51	1.127	.7297	-.1134
36.06	1.087	.7639	-.1189
37.51	1.047	.7826	-.1290
34.61	1.125	.7297	-.1051

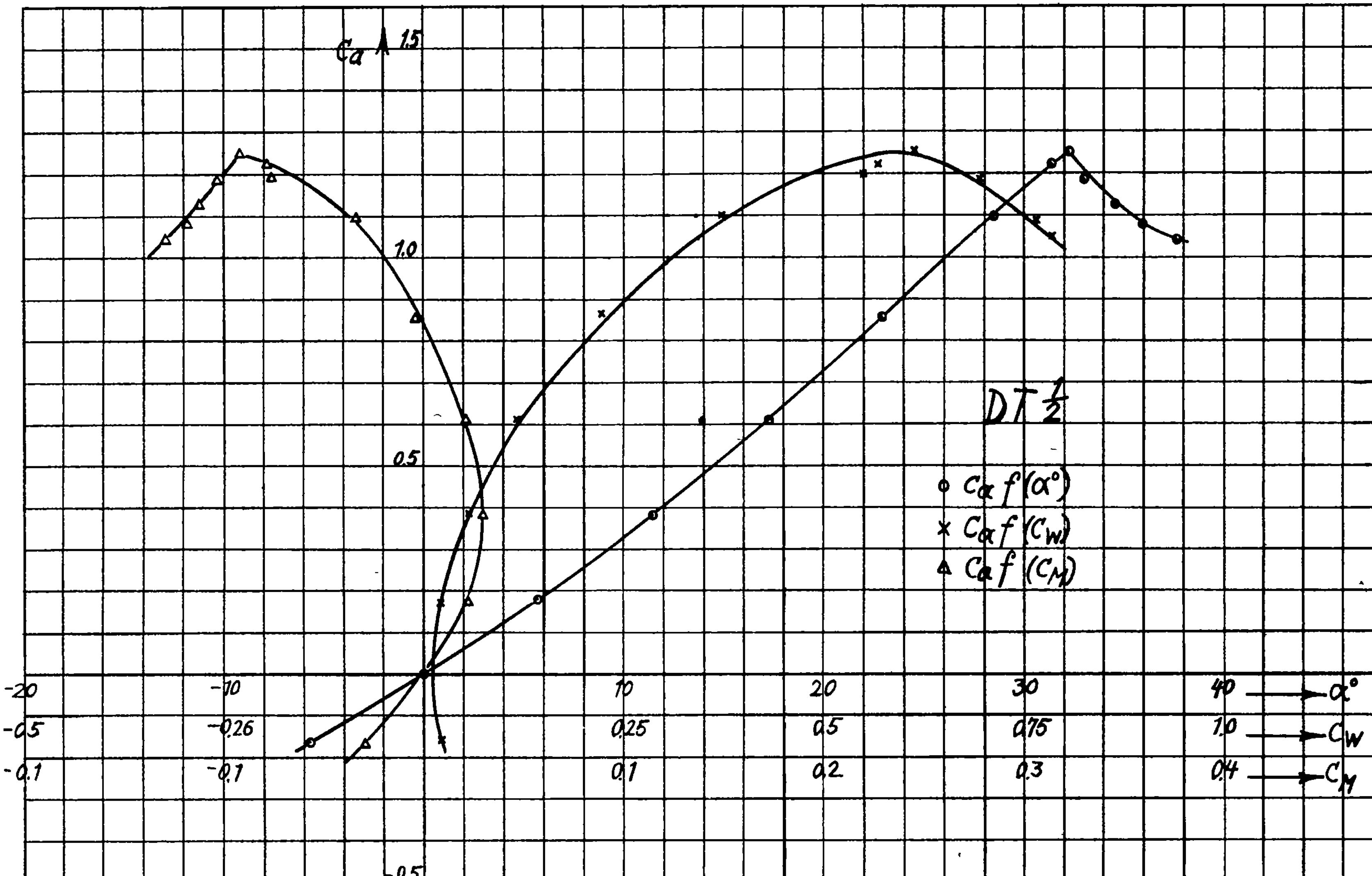

Chart 1.- 3-component measurement of a series of tapered wings.

Table 1.- Trapezoidal wing with fuselage.

SIX-COMPONENT MEASUREMENTS OF A SERIES OF TAPERED WINGS

(Trapezoid Wing With Fuselage)

TABLE NO. 2 TO CHARTS 2,3

DT 1/2 With Fuselage

$\alpha = 0^{\circ}$

β°	c_a	c_q	c_w	c_L	c_M	c_N
-4	0.0008	-0.0047	0.0127	-0.0025	0.0005	-0.0154
-2	.0015	-.0023	.0123	-.0032	.0004	-.0060
0	.0015	.0001	.0120	-.0023	.0003	.0032
2	0	.0033	.0127	-.0025	-.0008	.0126
4	.0007	.0070	.0133	-.0023	-.0010	.0215
6	.0010	.0107	.0140	-.0025	-.0014	.0295
10	.0022	.0207	.0173	-.0032	-.0025	.0402
15	.0048	.0387	.0247	-.0039	-.0048	.0441
20	.0093	.0600	.0354	-.0039	-.0099	.0453

$\alpha = 9,0^{\circ}$

β°	c_a	c_q	c_w	c_L	c_M	c_N
-4	0.2986	-0.0037	0.0381	-0.0197	0.0276	-0.0108
-2	.3006	-.0013	.0377	-.0103	.0264	-.0035
0	.2998	.0017	.0381	-.0011	.0266	.0030
2	.2989	.0050	.0381	.0098	.0264	.0102
4	.2984	.0080	.0387	.0195	.0249	.0173
6	.2996	.0110	.0401	.0297	.0219	.0237
10	.3046	.0190	.0443	.0478	.0134	.0334
15	.3142	.0323	.0533	.0668	-.0024	.0372
20	.3183	.0497	.0645	.0827	-.0143	.0248

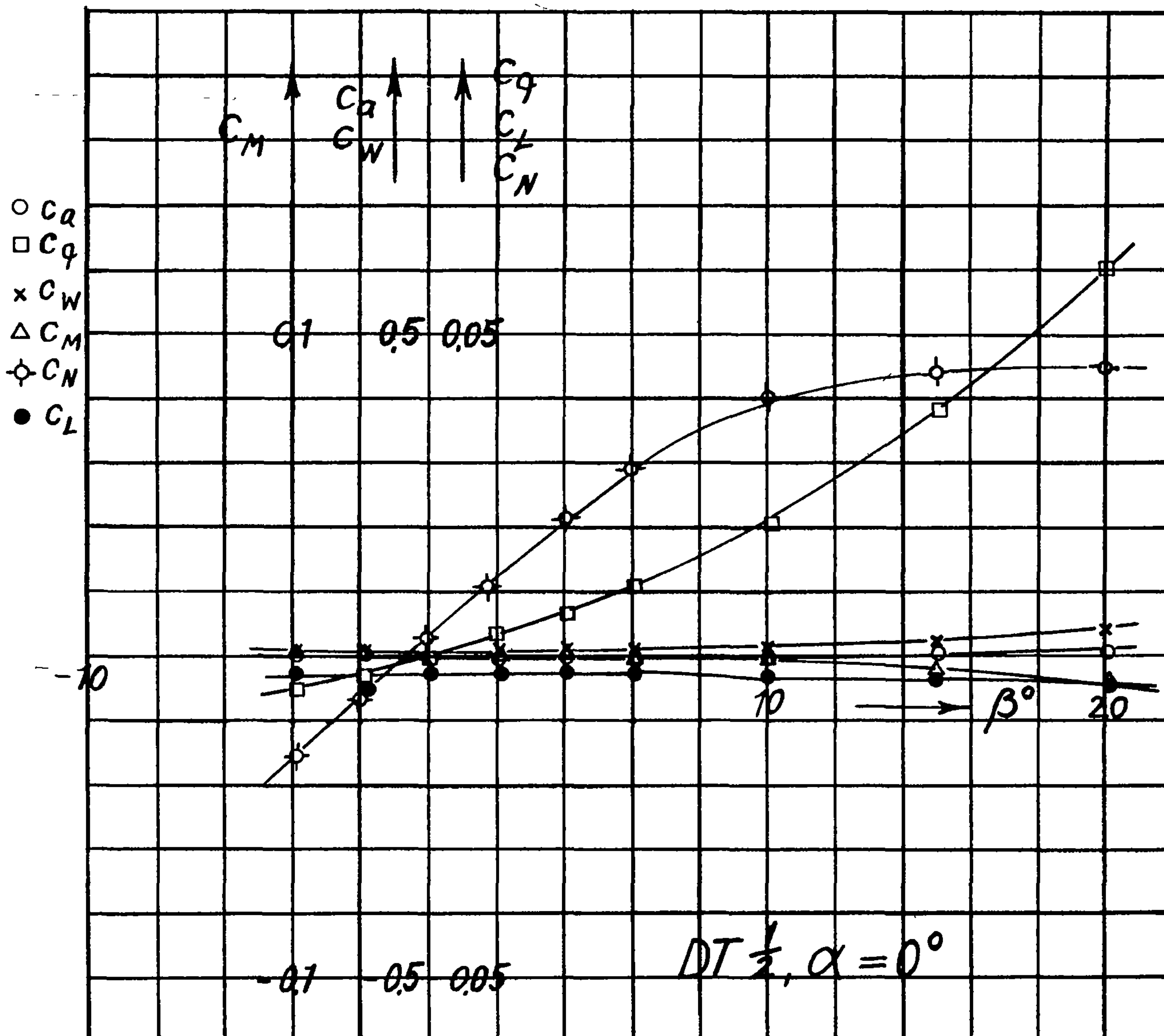

Chart 2.- 6-component measurement of a series of tapered wings.
Table 2.- Trapezoidal wing with fuselage.

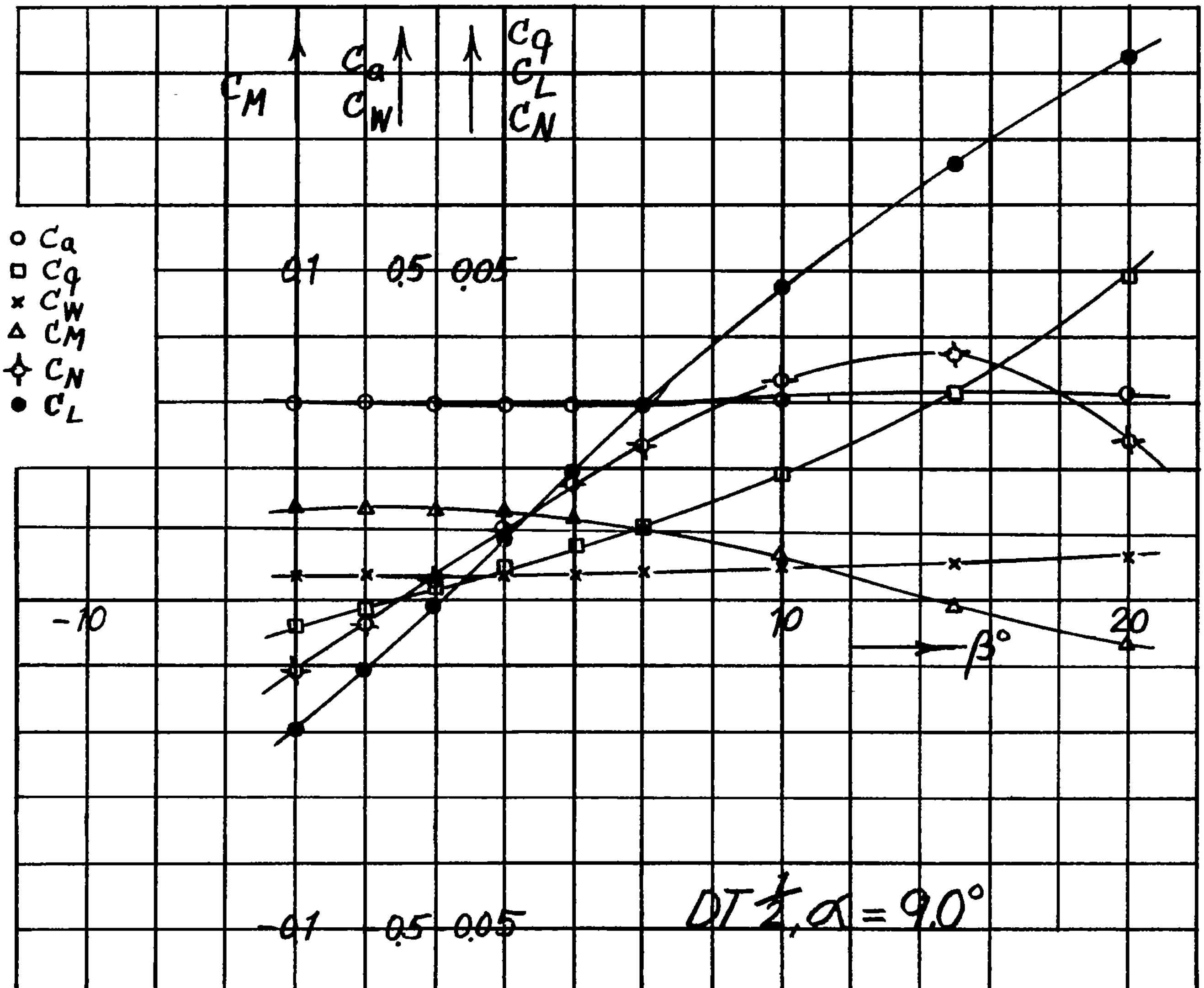

Chart 3.- 6-component measurement of a series of tapered wings.
Table 2.- Trapezoidal wing with fuselage.

SIX-COMPONENT MEASUREMENTS OF A SERIES OF TAPERED WINGS

(Trapezoid Wing With Fuselage)

TABLE NO. 3 TO CHARTS 4, 5

DT 1/2 with Fuselage

$\alpha = 16.45^\circ$

β°	c_a	c_q	c_w	c_L	c_M	c_N
-4	0.567	-0.0007	0.1074	-0.0329	0.0267	-0.0021
-2	.570	.0010	.1079	-.0183	.0260	.0011
0	.572	.0023	.1079	-.0008	.0251	.0042
2	.571	.0030	.1081	.0150	.0248	.0076
4	.569	.0043	.1082	.0309	.0234	.0108
6	.568	.0057	.1091	.0465	.0206	.0142
10	.566	.0086	.1123	.0752	.0122	.0181
15	.564	.0147	.1196	.1054	-.0020	.0181
20	.562	.0246	.1295	.1252	-.0184	.0117

$\alpha = 23.08^\circ$

β°	c_a	c_q	c_w	c_L	c_M	c_N
-4	0.848	0.0083	0.2260	-0.0424	-0.0021	0.0056
-2	.852	.0047	.2270	-.0208	-.0026	.0053
0	.854	.0013	.2280	-.0002	-.0029	.0045
2	.854	-.0020	.2274	.0203	-.0040	.0040
4	.850	-.0053	.2266	.0399	-.0056	.0037
6	.845	-.0083	.2264	.0599	-.0076	.0032
10	.844	-.0180	.2275	.0927	-.0165	.0036
15	.841	-.0296	.2310	.1254	-.0301	.0022
20	.821	-.0300	.2357	.1494	-.0410	-.0079

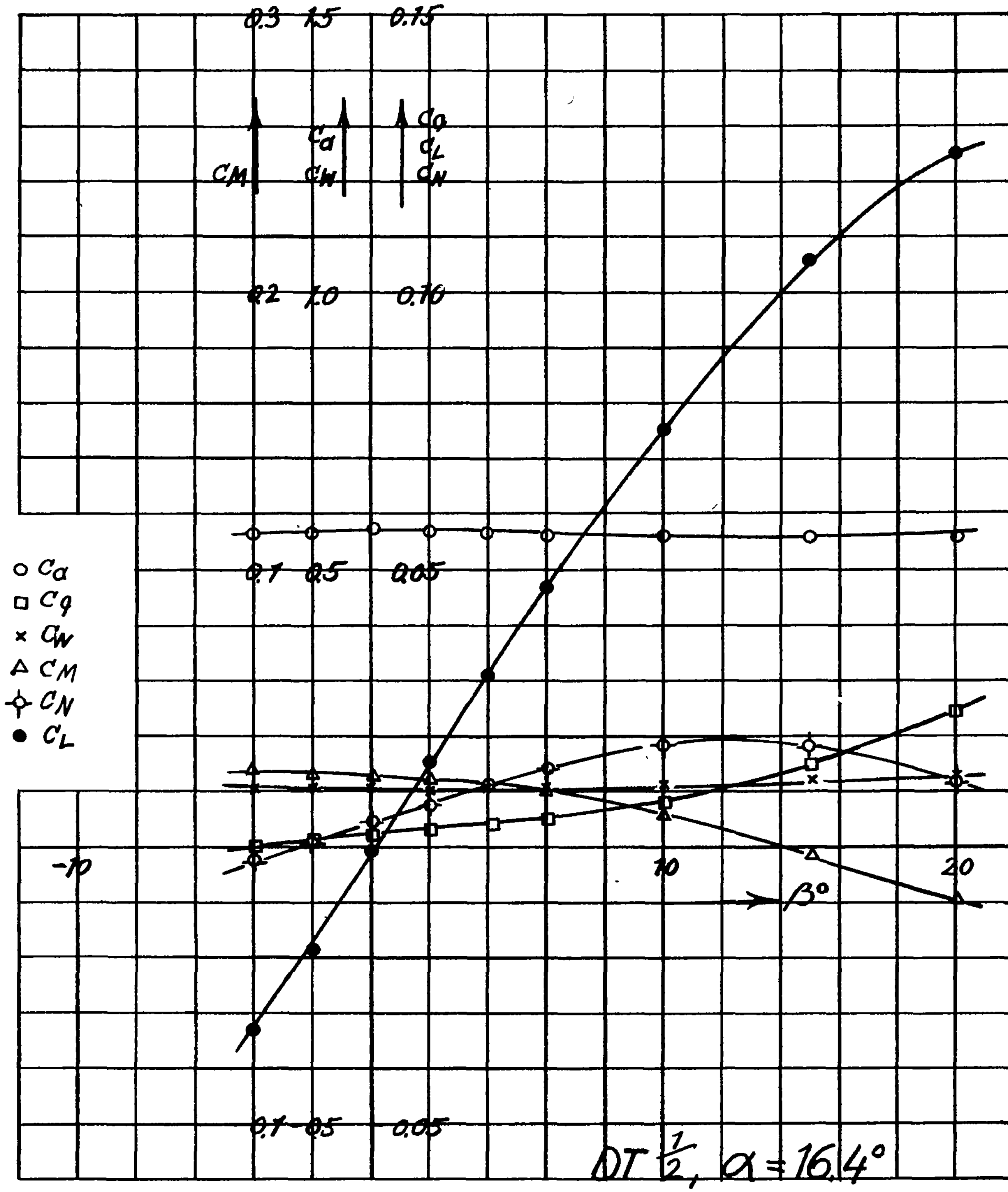

Chart 4.- 6-component measurement of a series of tapered wings.
Table 3.- Trapezoidal wing with fuselage.

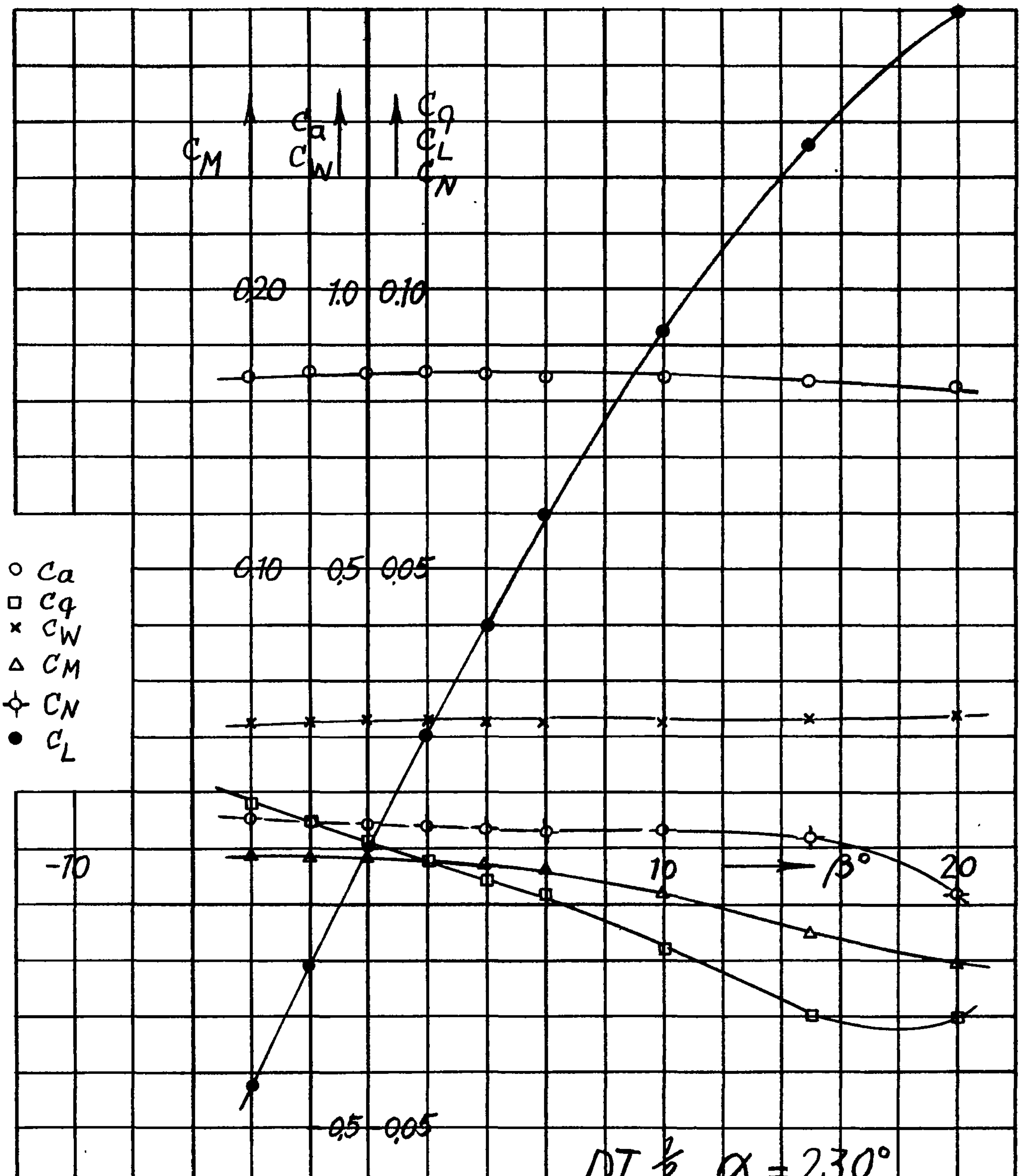

Chart 5.- Component measurement of a series of tapered wings.
Table 3.- Trapezoidal wing with fuselage.

SIX-COMPONENT MEASUREMENTS OF A SERIES OF TAPERED WINGS

(Trapezoid Wing with Fuselage)

TABLE NO. 4 TO CHART 6

DT 1/2 with Fuselage

$\alpha = 32.3^{\circ}$

β°	c_a	c_q	c_w	c_L	c_M	c_N
-4	1.219	-0.0250	0.6525	0.0191	-0.0884	-0.0042
-2	1.232	-.0383	.6625	.0260	-.0924	.0023
0	1.236	-.0516	.6647	.0326	-.0940	.0082
2	1.238	-.0716	.6626	.0442	-.0926	.0175
4	1.238	-.0859	.6517	.0529	-.0948	.0270
6	1.244	-.0949	.6474	.0569	-.0975	.0288
10	1.229	-.1132	.6258	.0646	-.0985	.0261
15	1.186	-.1242	.5729	.0857	-.0963	.0145
20	1.123	-.1538	.5311	.1232	-.1094	.0175

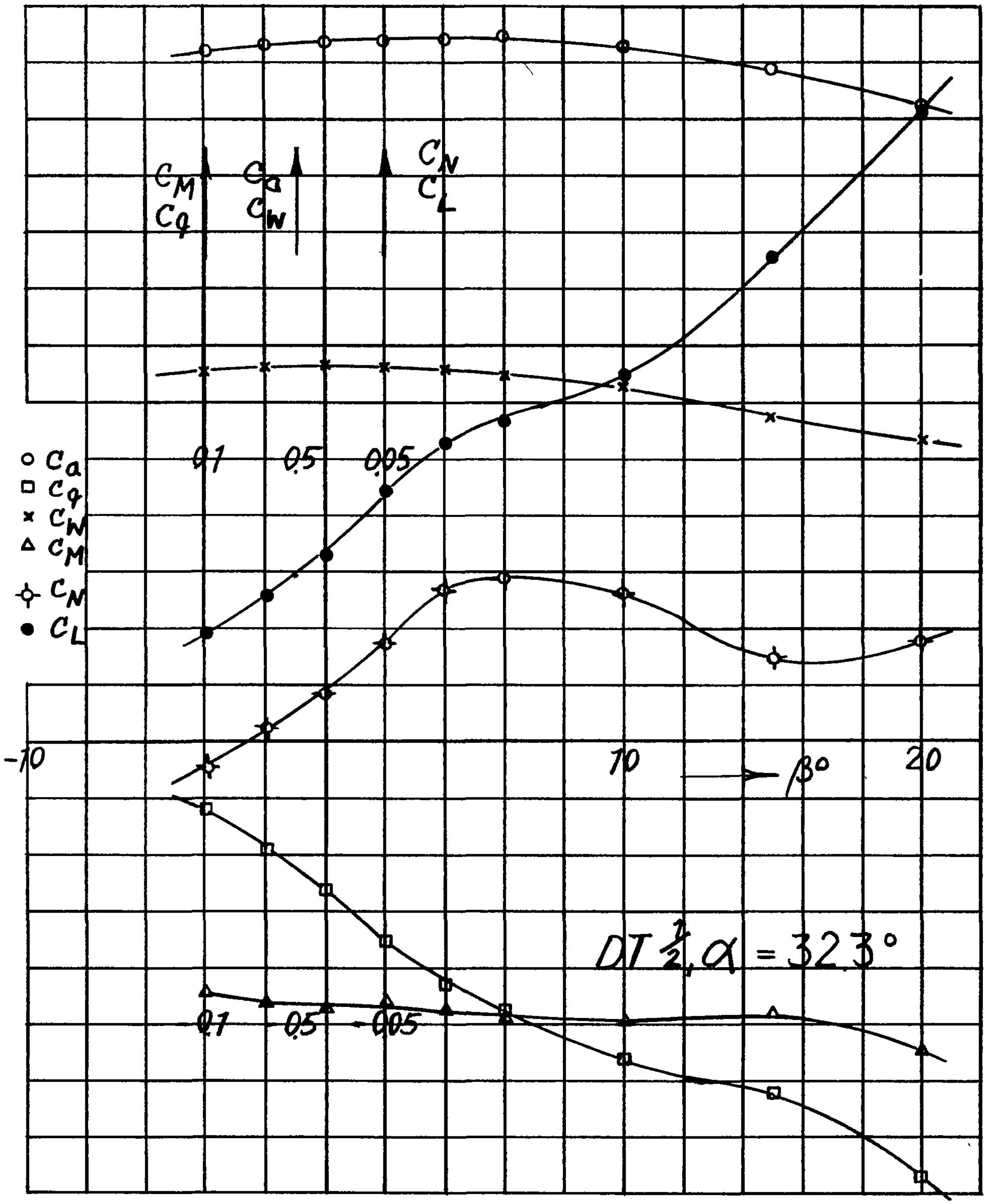

Chart 6.- Component measurement of a series of tapered wings.
Table 4.- Trapezoidal wing with fuselage.

THREE-COMPONENT MEASUREMENTS OF A SERIES OF TAPERED WING

(Trapezoid Wing with Fuselage)

TABLE NO. 5 TO CHART 7

DT 1/4 with Fuselage

α^o	c_a	c_w	c_M
-5.79	-0.168	0.0208	-0.0113
0	.001	.0116	-.0001
5.78	.171	.0209	.0103
11.54	.350	.0507	.0150
17.26	.570	.1097	-.0115
22.96	.798	.2080	-.0421
28.67	1.023	.3798	-.0909
34.49	1.150	.6037	-.1368
36.46	1.174	.6810	-.1570
37.47	1.170	.7161	-.1597
38.47	1.168	.7455	-.1623
39.49	1.165	.7776	-.1658
40.56	1.090	.7974	-.1587

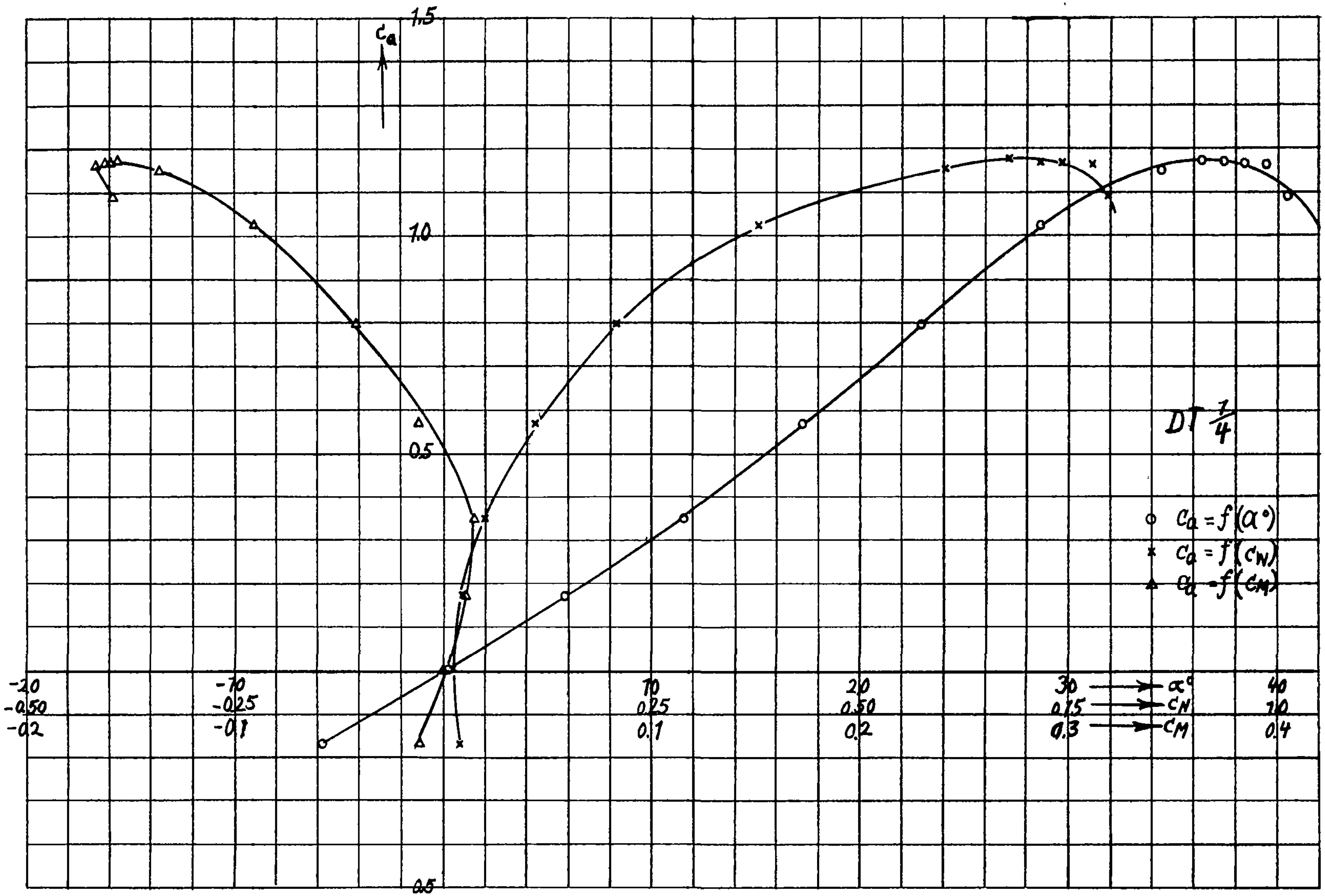

Chart 7.- 3-component measurement of a series of tapered wings.
Table 5.- Trapezoidal wing with fuselage.

SIX-COMPONENT MEASUREMENTS OF A SERIES OF TAPERED WING

(Trapezoid Wing with Fuselage)

TABLE NO. 6 TO CHARTS 8, 9

DT 1/4 with Fuselage

$\alpha = 0^\circ$

β°	c_a	c_q	c_w	c_L	c_M	c_N
-4	0.0033	-0.0047	0.0127	0.0035	-0.0013	-0.0159
-2	.0037	-.0022	.0123	.0024	-.0012	-.0060
0	.0033	.0007	.0120	.0033	-.0013	.0026
2	.0022	.0033	.0123	.0027	-.0006	.0125
4	.0015	.0057	.0130	.0026	-.0006	.0215
6	.0012	.0088	.0137	.0026	0	.0297
10	.0004	.0170	.0167	.0017	.0004	.0406
15	-.0008	.0336	.0234	.0012	.0019	.0442
20	-.0025	.0536	.0334	.0009	.0041	.0436

$\alpha = 9.63^\circ$

β°	c_a	c_q	c_w	c_L	c_M	c_N
-4	0.2991	-0.0027	0.0381	-0.0149	0.0106	-0.0133
-2	.3002	-.0008	.0381	-.0054	.0106	-.0055
0	.3011	.0013	.0381	.0022	.0105	.0015
2	.3011	.0037	.0381	.0117	.0105	.0086
4	.2985	.0063	.0384	.0207	.0105	.0157
6	.2979	.0092	.0393	.0296	.0095	.0219
10	.2967	.0150	.0421	.0447	.0032	.0318
15	.2978	.0276	.0491	.0605	.0001	.0361
20	.2979	.0456	.0581	.0715	-.0165	.0328

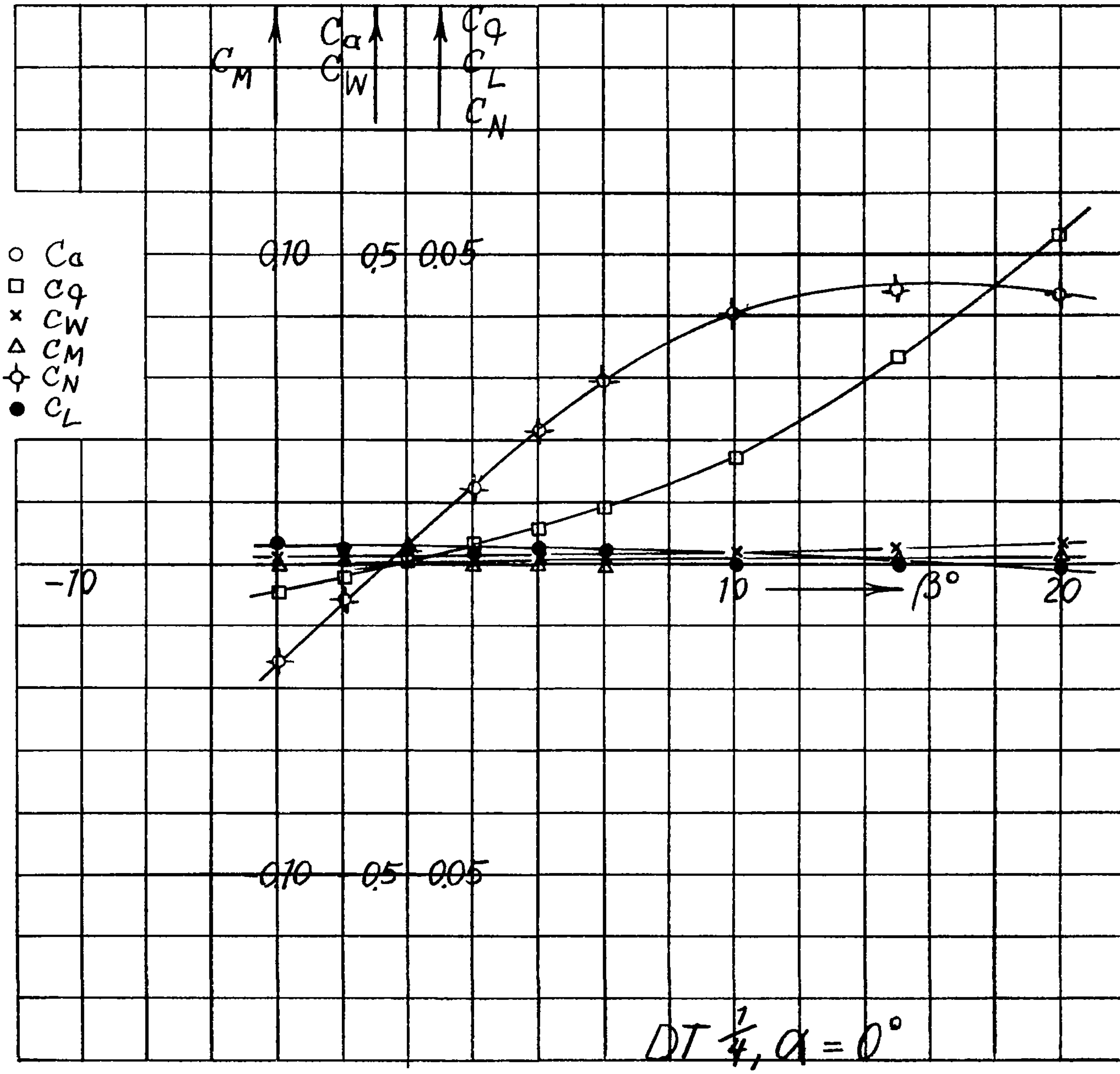

Chart 8.- 6-component measurement of a series of tapered wings.
Table 6.- Trapezoidal wing with fuselage.

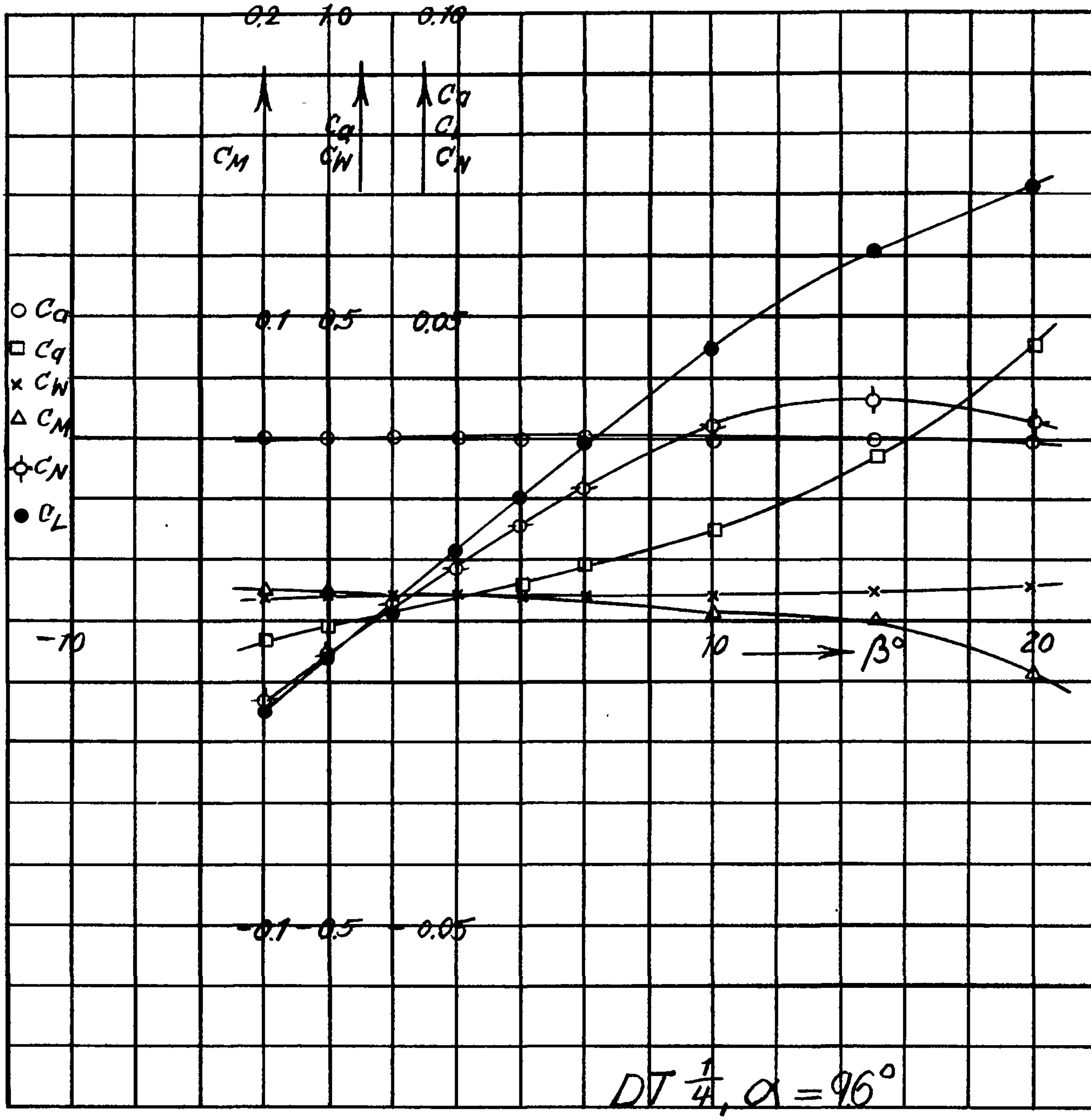

Chart 9.- 6-component measurement of a series of tapered wings.
Table 6.- Trapezoidal wing with fuselage.

SIX-COMPONENT MEASUREMENTS OF A SERIES OF TAPERED WING

(Trapezoid Wing with Fuselage)

TABLE NO. 7 TO CHARTS 10, 11

DT 1/4 with Fuselage

$\alpha = 17.65^\circ$

β°	c_a	c_q	c_w	c_L	c_M	c_N
-4	0.582	0.0017	0.1146	-0.0238	-0.0121	-0.0072
-2	.585	.0015	.1145	-.0104	-.0124	-.0036
0	.587	.0017	.1148	.0031	-.0128	-.0003
2	.584	.0020	.1149	.0174	-.0128	.0037
4	.580	.0023	.1139	.0298	-.0121	.0075
6	.577	.0025	.1141	.0428	-.0131	.0113
10	.575	.0020	.1164	.0669	-.0198	.0179
15	.568	.0050	.1217	.0929	-.0312	.0206
20	.556	.0100	.1294	.1143	-.0399	.0181

$\alpha = 23.74^\circ$

β°	c_a	c_q	c_w	c_L	c_M	c_N
-4	0.828	0.0117	0.2251	-0.0305	-0.0478	-0.0056
-2	.829	.0072	.2253	-.0138	-.0475	-.0040
0	.833	.0037	.2249	.0022	-.0476	-.0031
2	.828	0.	.2244	.0173	-.0479	-.0015
4	.822	-.0057	.2232	.0333	-.0477	.0020
6	.815	-.0105	.2219	.0482	-.0477	.0050
10	.810	-.0226	.2217	.0787	-.0527	.0117
15	.800	-.0366	.2277	.1101	-.0671	.0154
20	.761	-.0423	.2315	.1369	-.0522	.0045

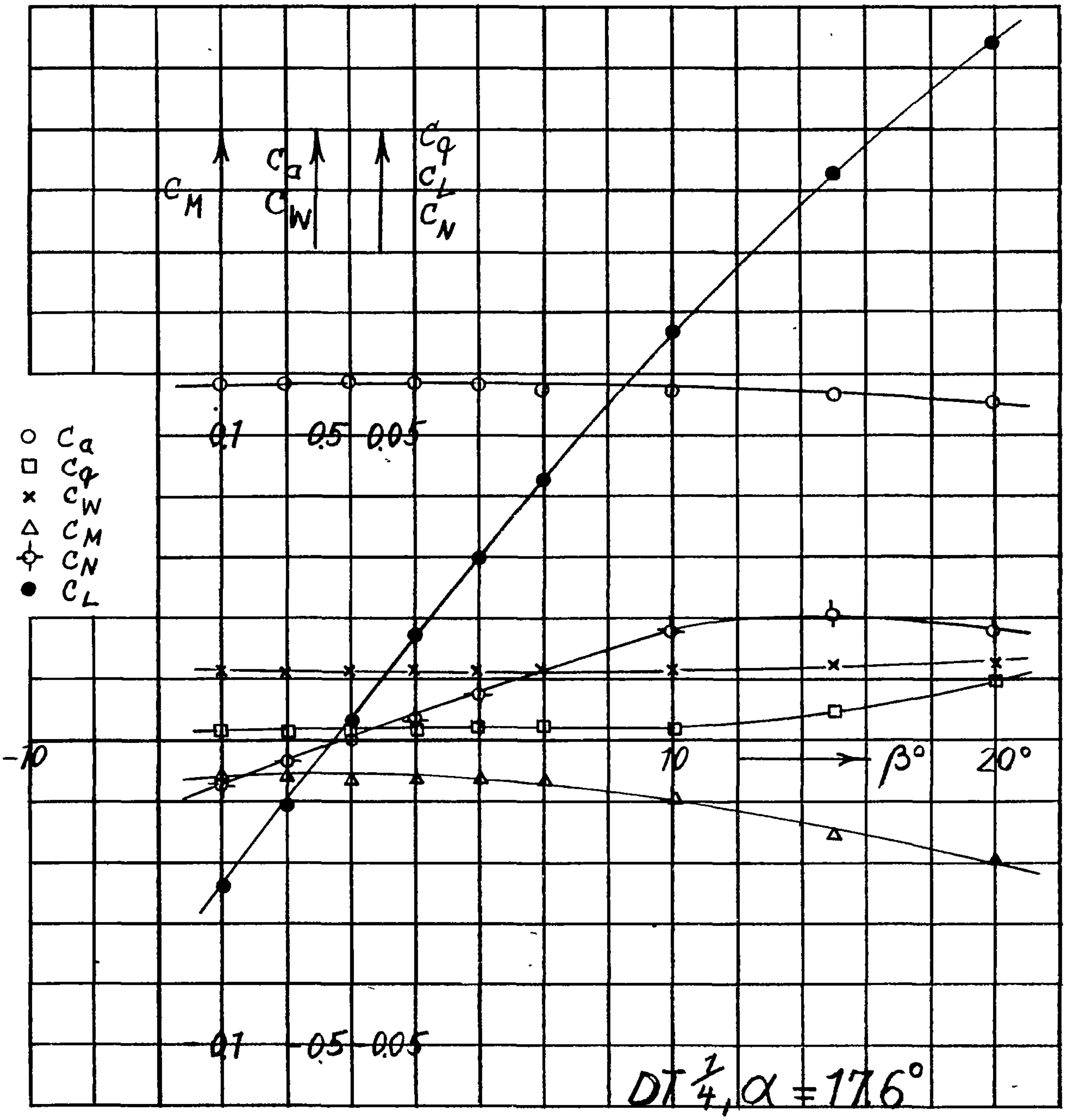

Chart 10.- 6-component measurement of a series of tapered wings.
Table 7.- Trapezoidal wing with fuselage.

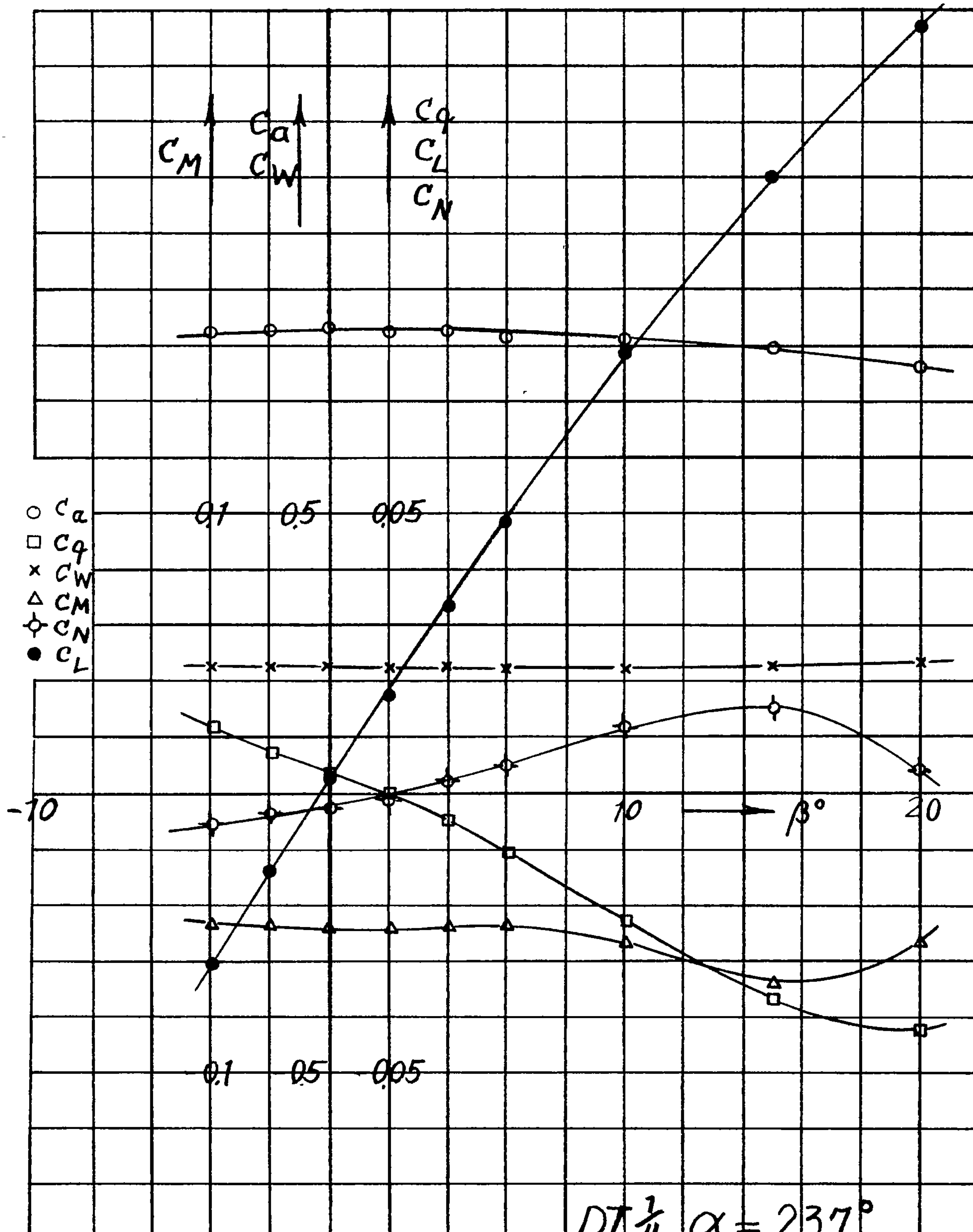

Chart 11.- 6-component measurement of a series of tapered wings.
Table 7.- Trapezoidal wing with fuselage.

SIX-COMPONENT MEASUREMENTS OF A SERIES OF TAPERED WING

(Trapezoid Wing with Fuselage)

TABLE NO. 8 TO CHART 12

DT 1/4 with Fuselage

$\alpha = 37.5^{\circ}$

β°	c_a	c_q	c_w	c_L	c_M	c_N
-4	1.060	0.0206	0.7289	-0.0164	-0.1762	-0.0104
-2	1.219	.0082	.7305	-.0053	-.1783	-.0016
0	1.222	-.0027	.7302	-.0008	-.1768	.0057
2	1.210	-.0156	.7282	.0070	-.1758	.0139
4	1.193	-.0270	.7212	.0146	-.1714	.0239
6	1.175	-.0334	.7112	.0203	-.1699	.0372
10	1.146	-.0566	.7144	.0382	-.1769	.0679
15	1.119	-.1015	.7066	.0726	-.1959	.0889
20	1.097	-.1461	.6924	.0977	-.2129	.0793

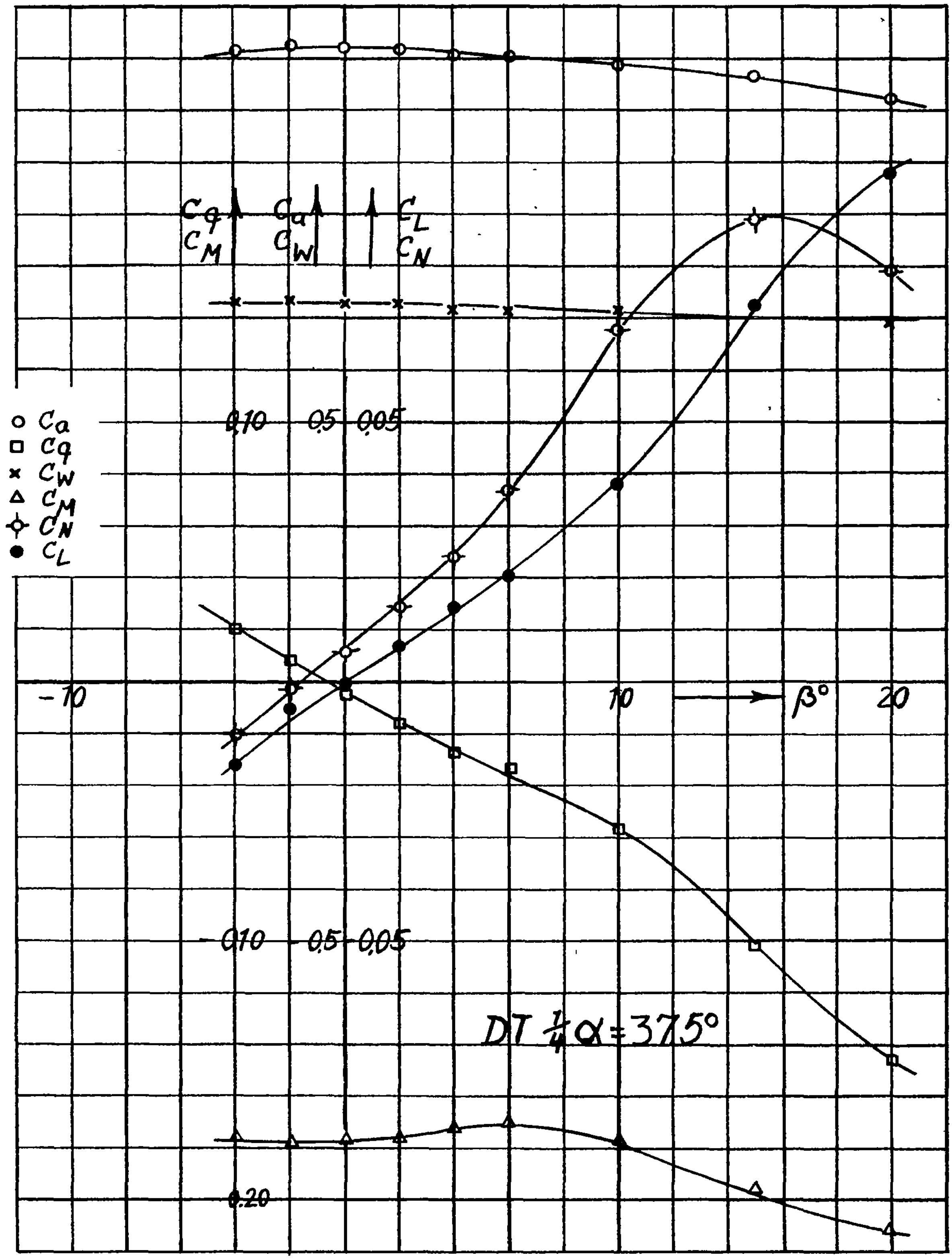

Chart 12.- 6-component measurement of a series of tapered wings.
Table 8.- Trapezoidal wing with fuselage.

THREE-COMPONENT MEASUREMENTS OF A SERIES OF TAPERED WING

(Trapezoid Wing with Fuselage)

TABLE NO. 9 TO CHART 13

DT 1/8 with Fuselage

α^o	c_a	c_w	c_M
-5.89	-0.1705	0.0216	-0.0056
.01	-.0066	.0138	-.0002
5.80	.1573	.0193	.0052
11.58	.3297	.0451	.0019
17.31	.5340	.1028	-.0214
23.05	.7325	.2044	-.0521
28.82	.9107	.3494	-.0899
31.71	.9900	.4367	-.1091
34.63	1.0520	.5306	-.1260
36.58	1.0820	.5950	-.1428
37.57	1.0870	.6317	-.1504
38.57	1.0940	.6634	-.1569

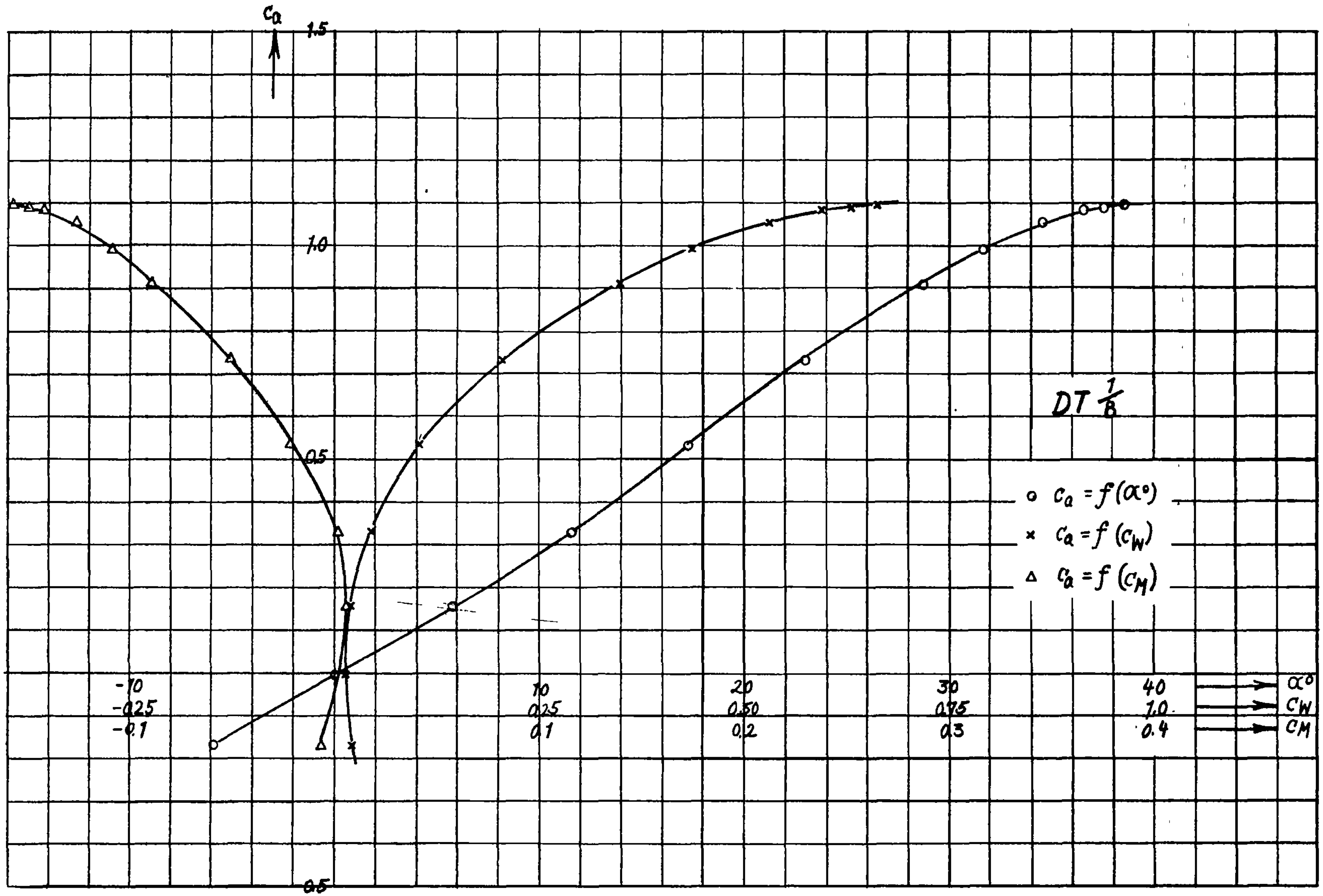

Chart 13.- 3-component measurement of a series of tapered wings.
Table 9.- Trapezoidal wing with fuselage.

SIX-COMPONENT MEASUREMENTS OF A SERIES OF TAPERED WING

(Trapezoid Wing with Fuselage)

TABLE NO. 10 TO CHARTS 14, 15

DT 1/8 with Fuselage

$\alpha = 0^\circ$

β°	c_a	c_q	c_w	c_L	c_M	c_N
-4	-0.0063	-0.0047	0.0118	0.0010	0.0003	-0.0170
-2	-.0060	-.0027	.0116	.0010	-.0001	-.0073
0	-.0059	.0003	.0113	.0009	-.0004	.0017
2	-.0069	.0028	.0116	.0006	.0003	.0113
4	-.0069	.0053	.0120	.0003	.0003	.0203
6	-.0063	.0090	.0132	.0001	.0003	.0289
10	-.0067	.0183	.0160	-.0006	.0009	.0367
15	-.0075	.0345	.0222	-.0007	.0022	.0427
20	-.0085	.0540	.0316	-.0013	.0037	.0407

$\alpha = 10.3^\circ$

β°	c_a	c_q	c_w	c_L	c_M	c_N
-4	0.2914	-0.0020	0.0367	-0.0162	0.0052	-0.0139
-2	.2919	0	.0365	-.0078	.0053	-.0070
0	.2925	.0023	.0365	.0007	.0052	.0004
2	.2917	.0045	.0365	.0100	.0054	.0078
4	.2916	.0066	.0370	.0183	.0050	.0146
6	.2891	.0093	.0380	.0266	.0040	.0215
10	.2879	.0157	.0412	.0404	-.0013	.0284
15	.2882	.0262	.0477	.0568	-.0078	.0377
20	.2811	.0423	.0581	.0683	-.0123	.0364

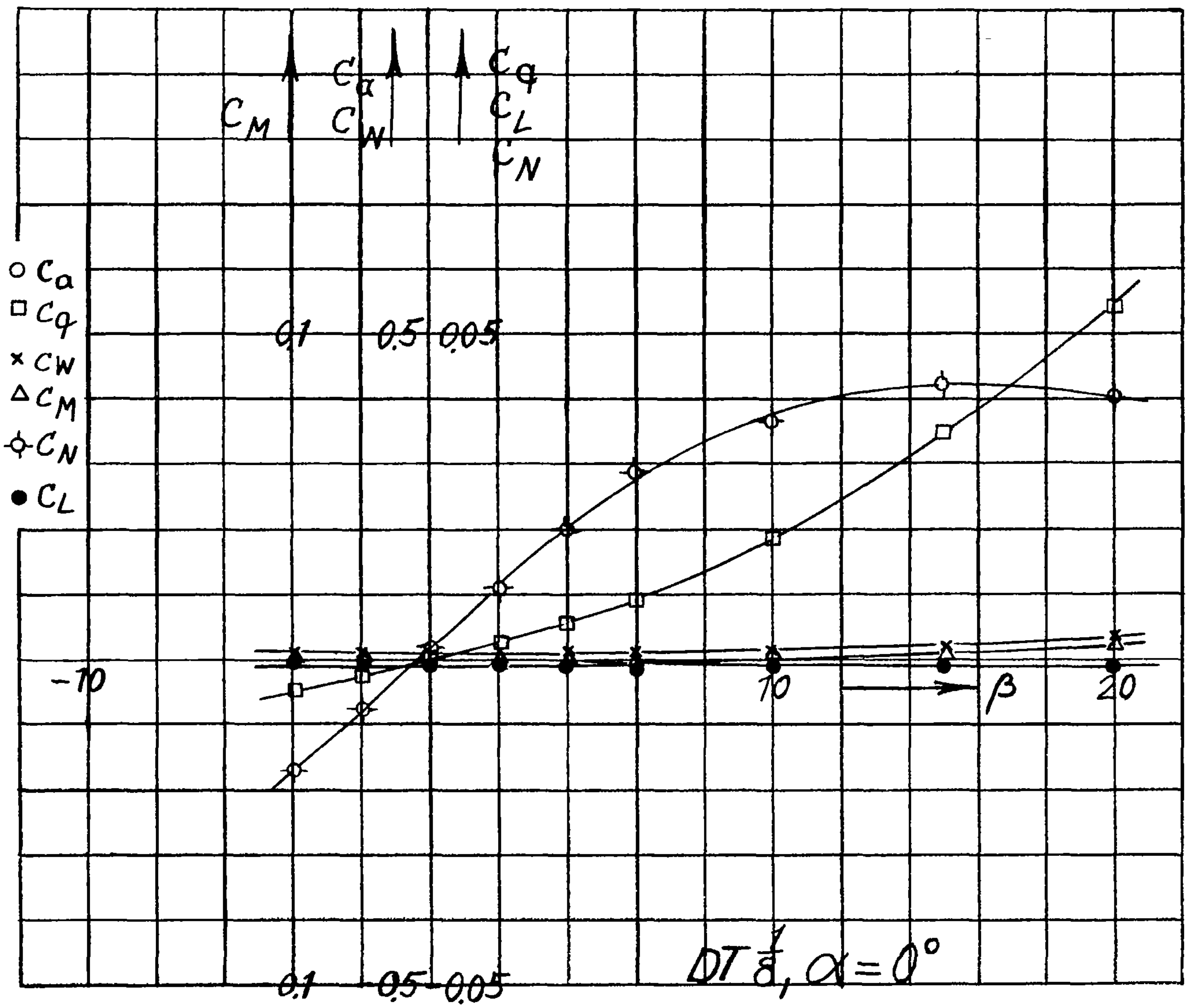

Chart 14.- 6-component measurement of a series of tapered wings.
Table 10.- Trapezoidal wing with fuselage.

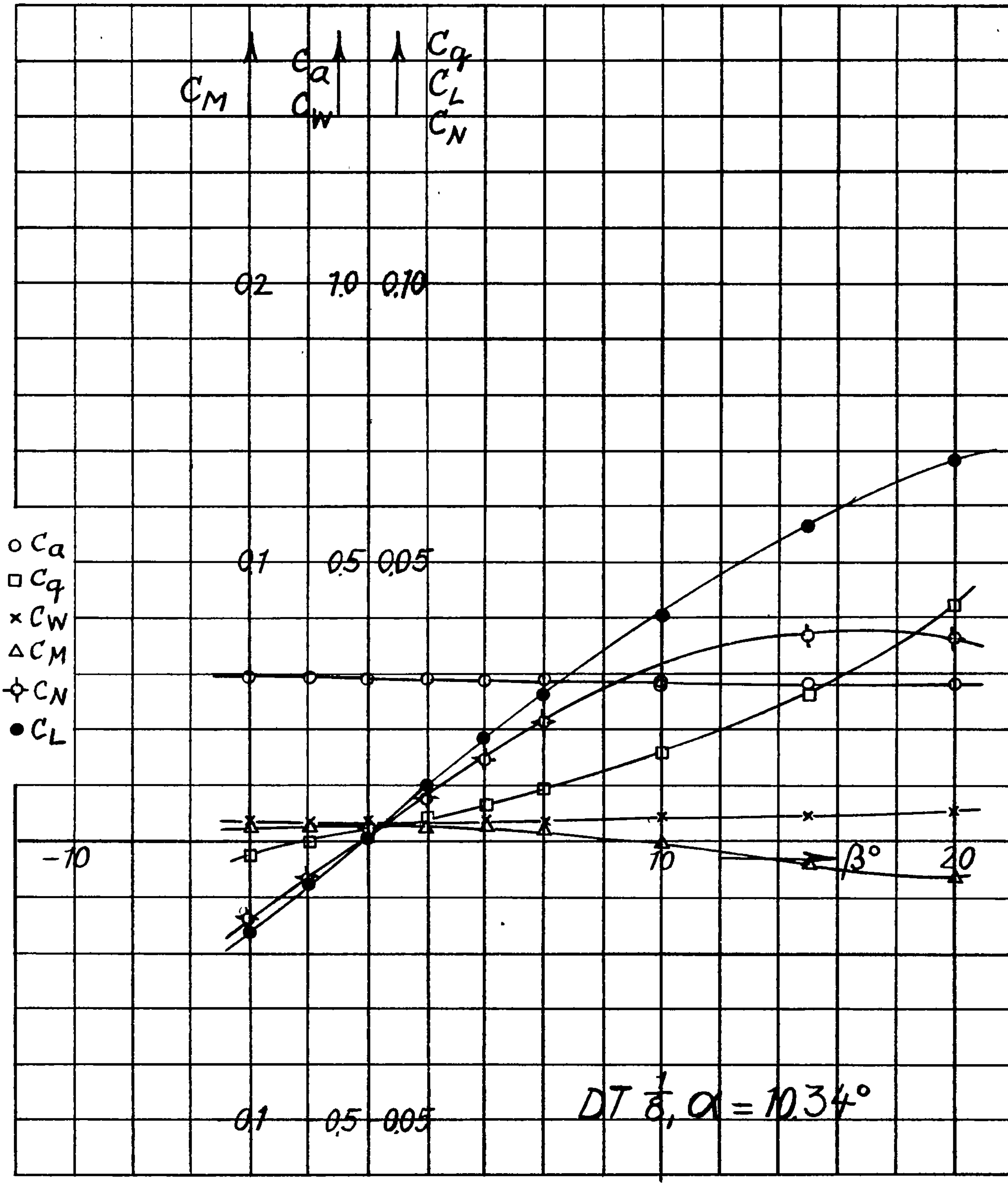

Chart 15.- 6-component measurement of a series of tapered wings.
Table 10.- Trapezoidal wing with fuselage.

SIX-COMPONENT MEASUREMENTS OF A SERIES OF TAPERED WING
(Trapezoid Wing with Fuselage)
TABLE NO. 11 TO CHARTS 16, 17

DT 1/8 with Fuselage

$\alpha = 19.04^\circ$

β°	c_ε	c_q	c_w	c_L	c_M	c_N
-4	0.6105	0.0080	0.1272	-0.0271	-0.0338	-0.0129
-2	.6120	.0053	.1269	-.0142	-.0345	-.0067
0	.6129	.0037	.1268	-.0009	-.0338	-.0005
2	.6120	.0012	.1272	.0126	-.0344	.0055
4	.6115	-.0010	.1274	.0254	-.0356	.0111
6	.6072	-.0030	.1279	.0382	-.0361	.0176
10	.5999	-.0063	.1285	.0595	-.0390	.0269
15	.5968	-.0095	.1344	.0876	-.0515	.0329
20	.5762	.0070	.1497	.1032	-.0545	.0107

$\alpha = 27.38^\circ$

β°	c_a	c_q	c_w	c_L	c_M	c_N
-4	0.869	0.0157	0.3068	-0.0318	-0.0804	-0.0060
-2	.870	.0083	.3070	-.0177	-.0793	-.0026
0	.871	.0017	.3062	-.0031	-.0798	.0005
2	.870	-.0052	.3064	.0119	-.0798	.0037
4	.868	-.0130	.3062	.0259	-.0800	.0065
6	.864	-.0203	.3061	.0410	-.0811	.0087
10	.856	-.0370	.3048	.0727	-.0845	.0114
15	.846	-.0558	.3016	.1081	-.0941	.0070
20	.827	-.0684	.3030	.1354	-.1022	-.0075

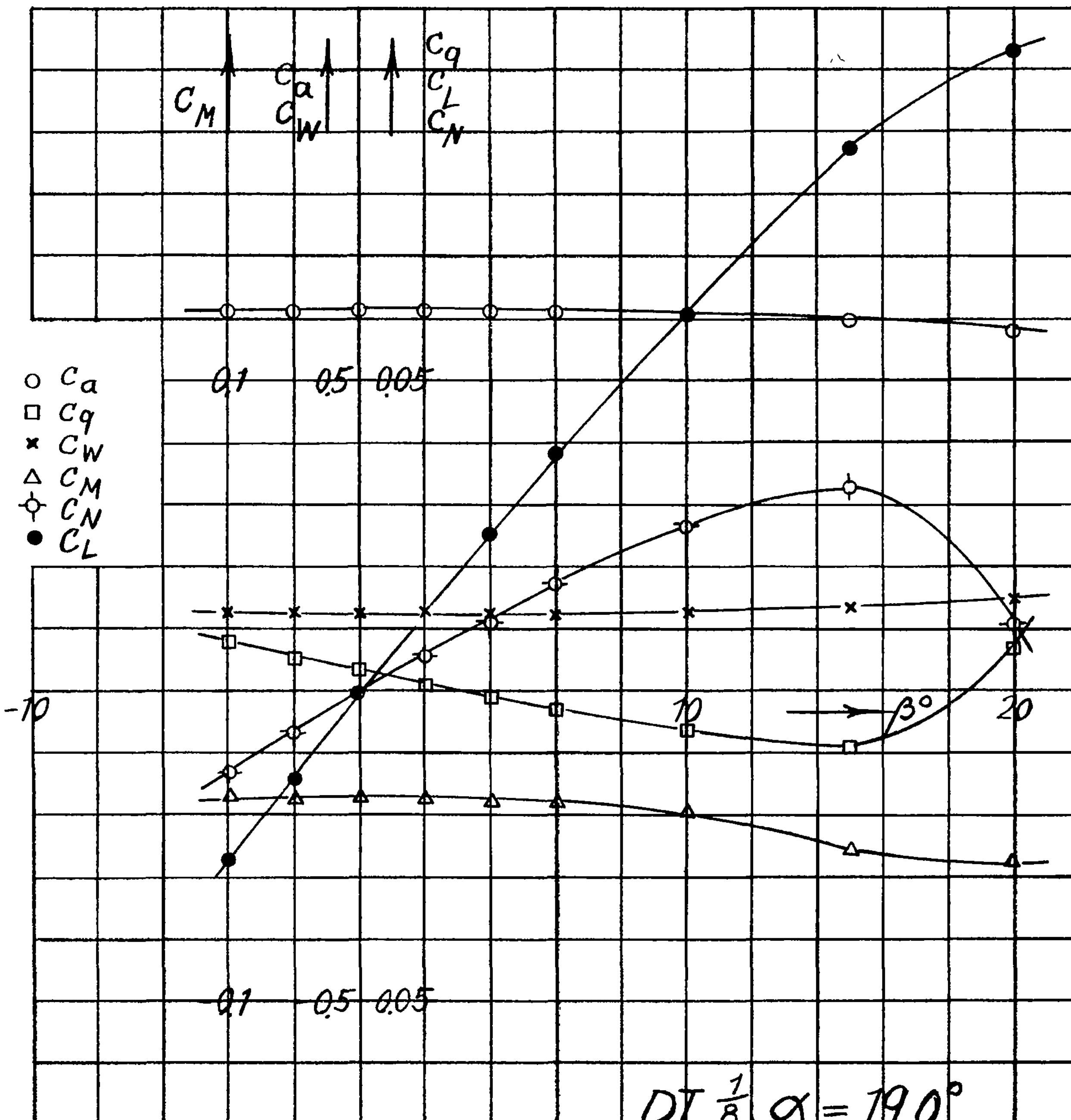

Chart 16.- 6-component measurement of a series of tapered wings.
Table 11.- Trapezoidal wing with fuselage.

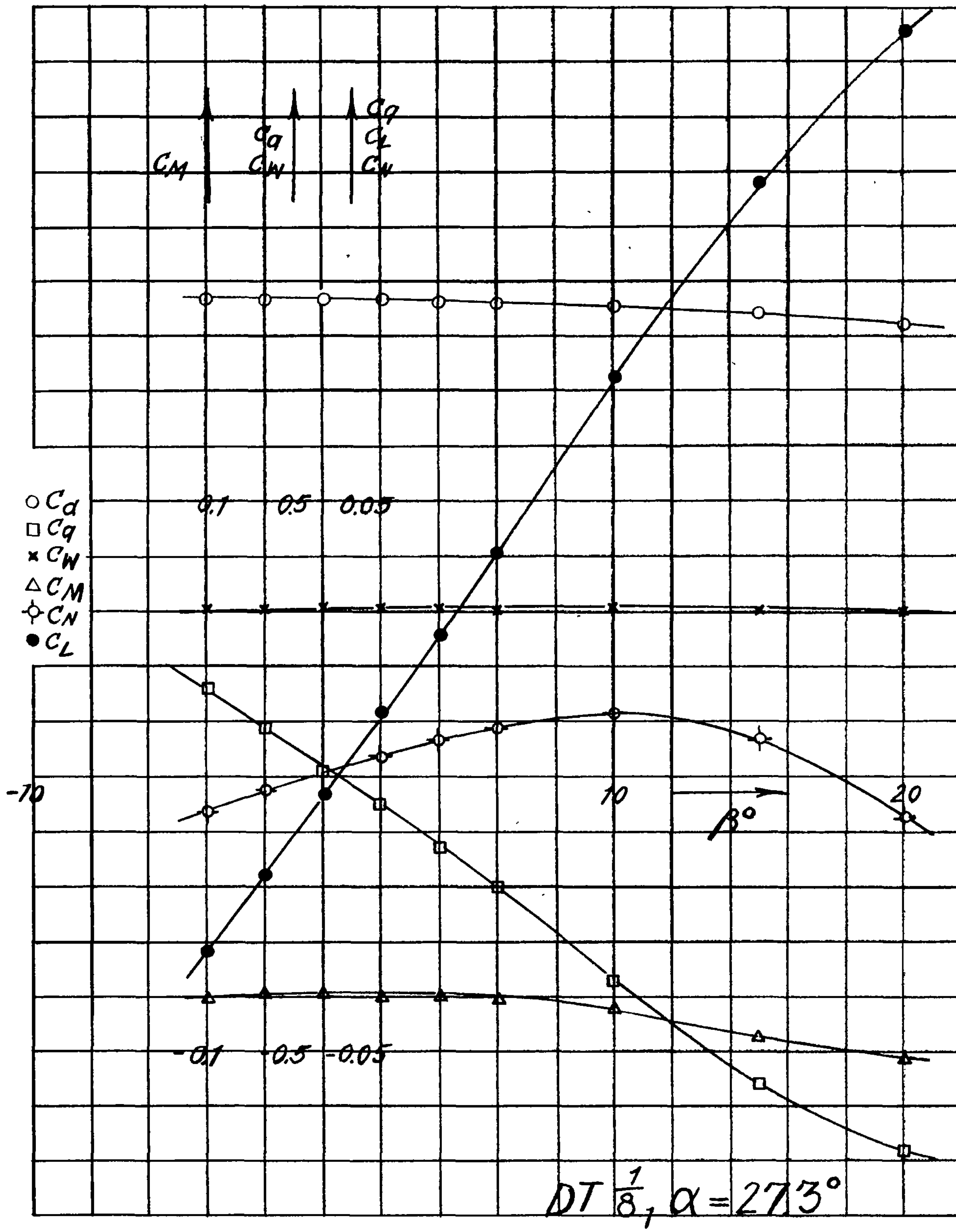

Chart 17.- 6-component measurement of a series of tapered wings.
Table 11.- Trapezoidal wing with fuselage.

SIX-COMPONENT MEASUREMENTS OF A SERIES OF TAPERED WING

(Trapezoid Wing with Fuselage)

TABLE NO. 12 TO CHART 18

DT 1/8 with Fuselage

$\alpha = 38.57^\circ$

β°	c_a	c_q	c_w	c_L	c_M	c_N
-4	1.095	0.0220	0.6522	-0.0238	-0.1578	-0.0161
-2	1.090	.0134	.6567	-.0179	-.1576	-.0035
0	1.095	-.0060	.6585	-.0034	-.1579	.0142
2	1.097	-.0195	.6615	.0082	-.1605	.0230
4	1.085	-.0324	.6595	.0222	-.1592	.0328
6	1.075	-.0524	.6565	.0327	-.1617	.0440
10	1.065	-.0914	.6509	.0637	-.1730	.0613
15	1.050	-.1300	.6424	.0885	-.1822	.0475
20	1.010	-.1560	.6244	.1052	-.1808	.0204

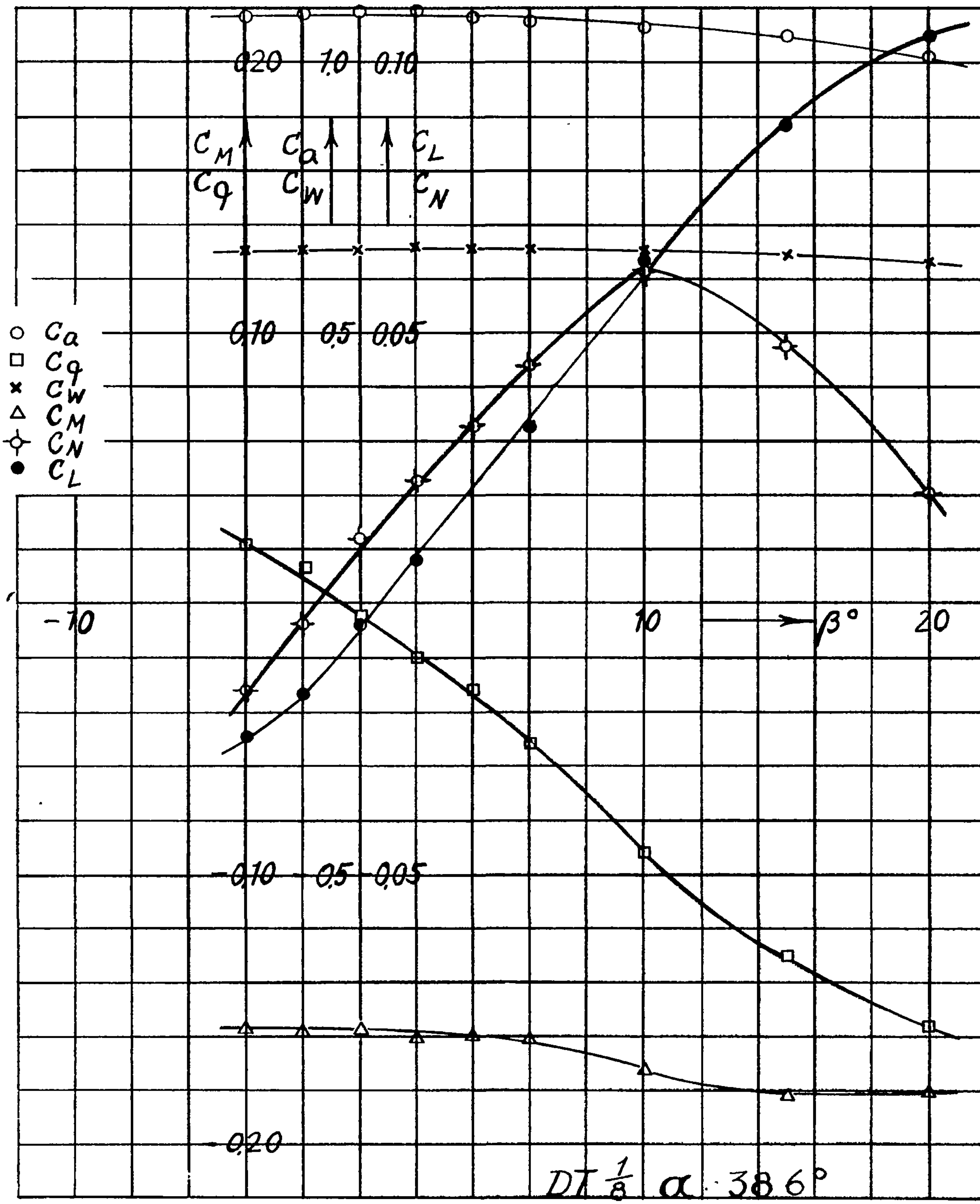

Chart 18.- 6-component measurement of a series of tapered wings.
Table 12.- Trapezoidal wing with fuselage.

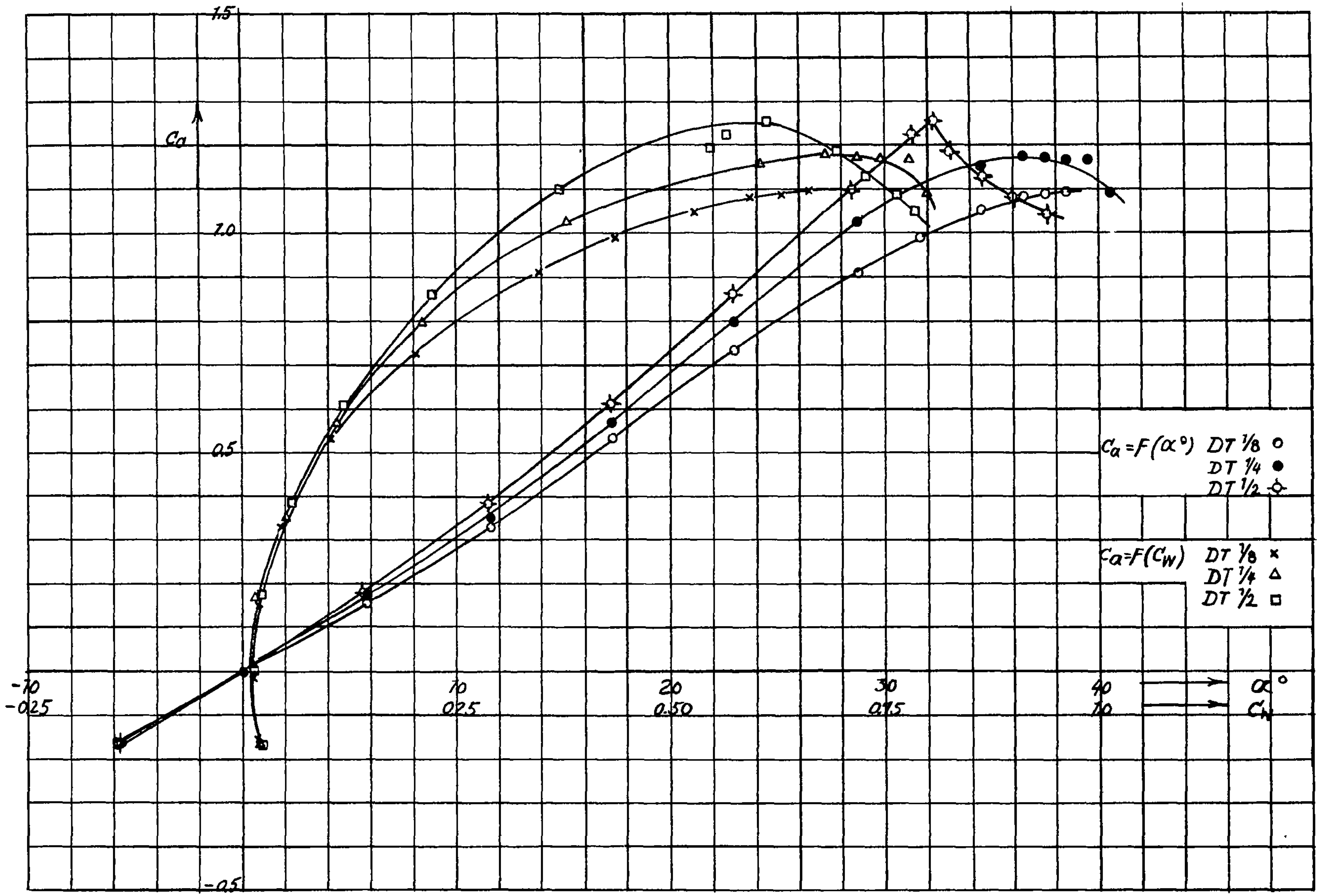

Chart 19.- $c_a = f(\alpha)$- and $c_a = f(c_w)$-curves of the series of the trapezoidal wings with fuselage.

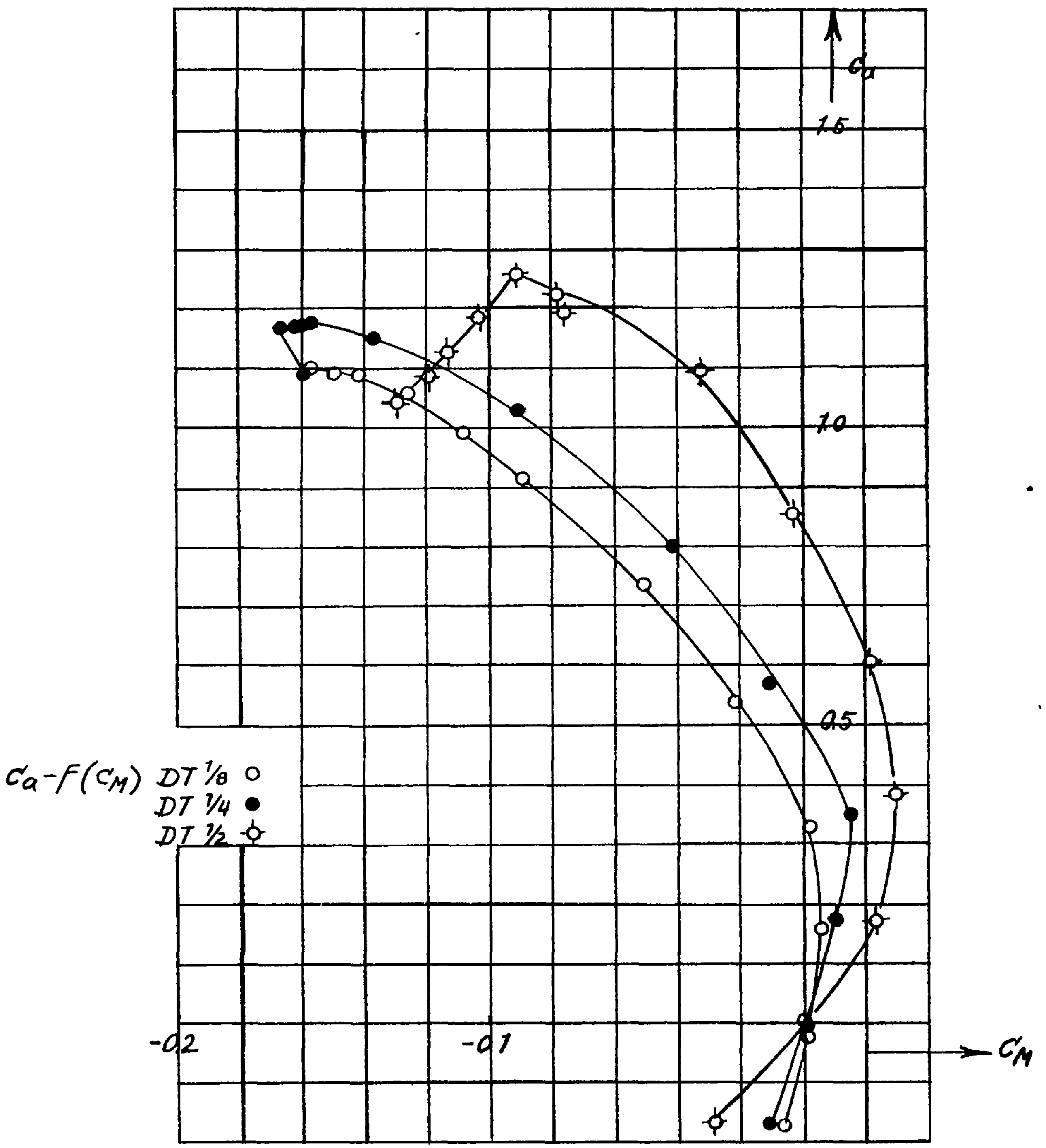

Chart 20.- $c_a = f(c_M)$-curves of the series of the trapezoidal wings with fuselage.

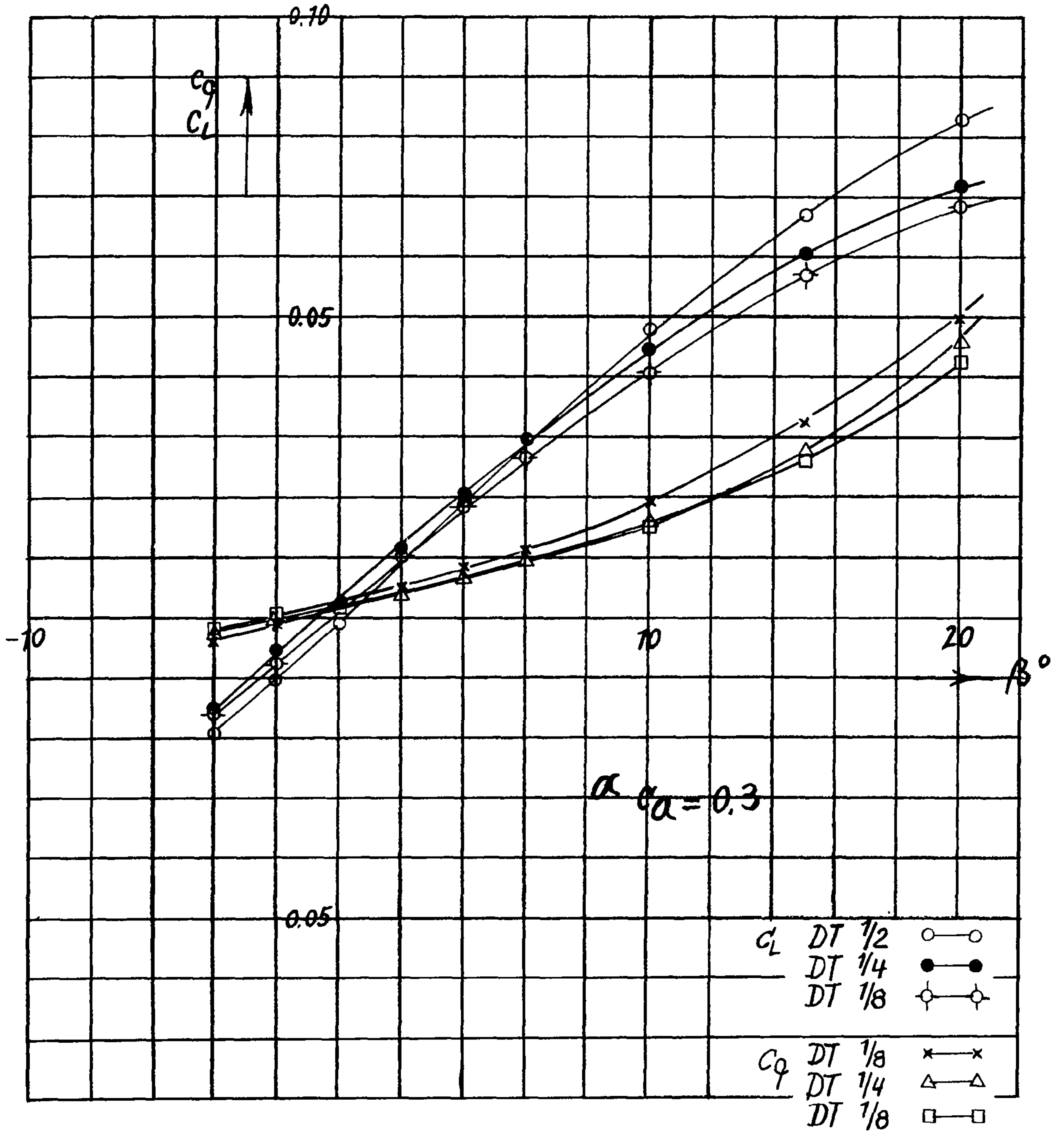

Chart 21.- c_L- and cg-curves of the series of the trapezoidal wings with fuselage.

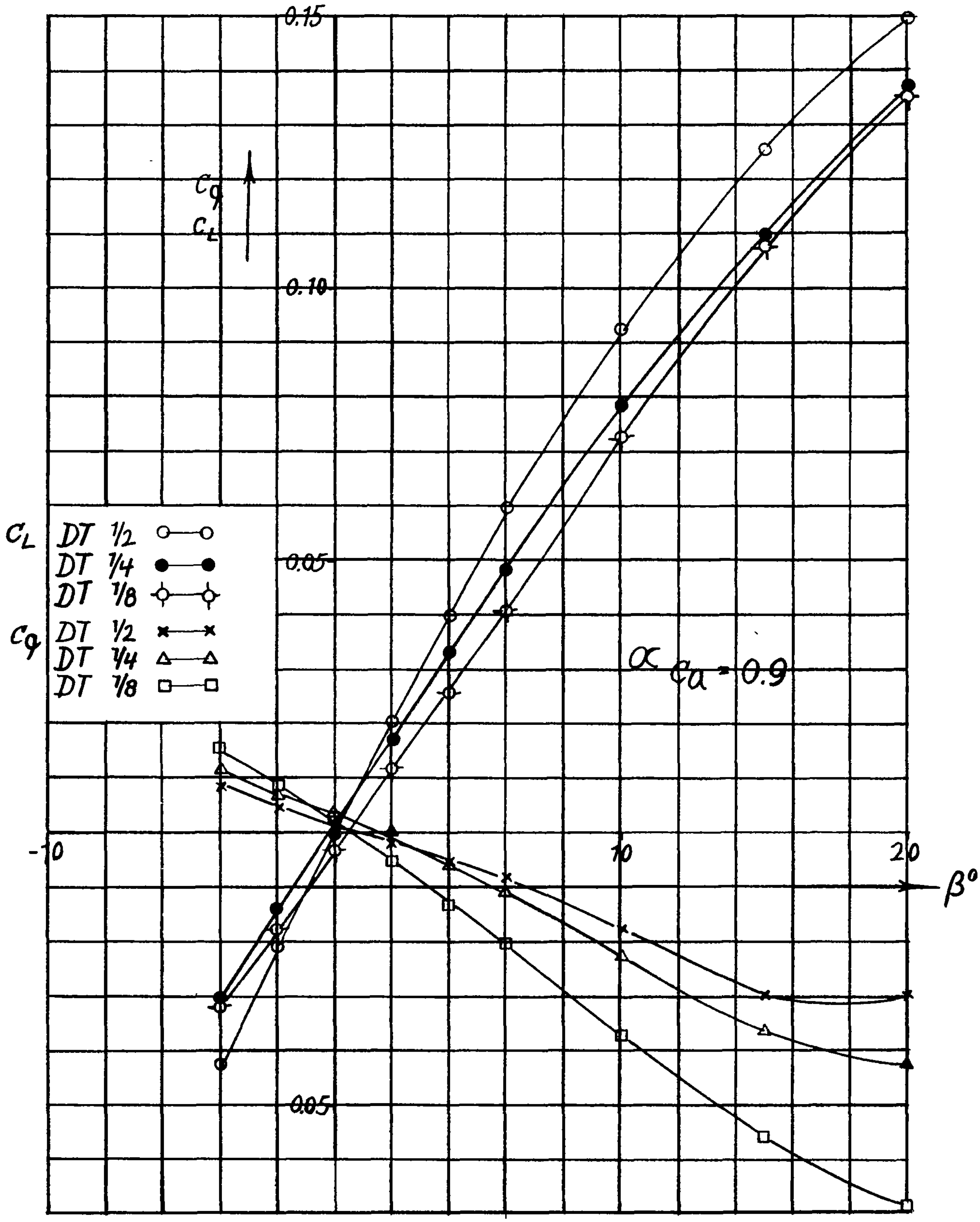

Chart 22.- c_L- and cg-curves of the series of the trapezoidal wings with fuselage.