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TECHNICAL NOTES

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

No. 343

THE CHARACTERISTICS OF THE N.A.C.A. M-12 AIRFOIL SECTION

By George J Higgins
Langley Memorial Aeronautical Laboratory

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Summary

The data obtained on the N.A.C.A. M-12 airfoil, tested at twenty atmospheres density in the National Advisory Committee for Aeronautics variable density wind tunnel, have been extended by additional tests at one and at twenty atmospheres under improved conditions. The results of these tests are given. Considerable scale effect was found.

The Tests

The data on the N.A.C.A. M-12 airfoil were extended for comparison and to determine scale effect by testing the model in the National Advisory Committee for Aeronautics variable density wind tunnel at one atmosphere density. As the original test at twenty atmospheres was made some time ago under conditions which have since been improved, a re-test at that density was also made. The latter represents a Reynolds Number of 3,480,000, which is about the condition of full dynamic scale.

The original duralumin airfoil model of the N.A.C.A. M-12 section, (Table I), with an aspect ratio 6 and with a plan form of 5 in. by 30 in. was used. It was mounted in the tunnel in

the usual manner as described in Reference 1. Fairings were added, covering the lower half of the streamlined supports, thus reducing the tare drag by half. The angle of attack was varied from -3° to $+24^{\circ}$ with observations taken at $1\frac{1}{2}^{\circ}$ intervals.

Results

The results of the tests are given in Tables II and III, and are plotted in Fig. 1. Curves are also plotted representing the lift, moment, and minimum induced drag coefficients as calculated from theory (References 2 and 3).

When a comparison is made of the high Reynolds Number test with the low, it may be seen that there is a big delay in the angle at which burbling occurs, and also a large increase in the maximum lift coefficient. The angle of zero lift is in agreement with the theoretical value in both tests. The slope of the lift curve at the higher density is normal and has a value of 0.0710. This is about 86 per cent of the theoretical slope for an airfoil of the same aspect ratio, a usual figure for this tunnel. However, the lift curve slope at the lower density is very irregular. For a portion of its range (3°) its value is well above that for the theoretical slope (.0960/.0822), indicating that a peculiar type of flow is created at these angles. A similar occurrence has been noticed in tests made at low densities on other airfoils of this same general shape. The remainder of the lift curve is normal, though

the slope is low. This increase in lift coefficient at one atmosphere explains why the polar curve of that test is better through its mid-portion.

The drag characteristics are slightly improved at the higher Reynolds Number. There is also a slight change in stability; the twenty-atmosphere moment coefficient agrees very well with that calculated.

For determining airfoil characteristics, tests at high Reynolds Numbers are of great importance.

References

1. Munk, Max M. and Miller, Elton W. : The Variable Density Wind Tunnel of the National Advisory Committee for Aeronautics. N.A.C.A. Technical Report No. 227 - 1926. Part II, pp. 14-15, Fig.10.

2. Munk, Max M. : The Determination of the Angles of Attack of Zero Lift and of Zero Moment, Based on Munk's Integrals. N.A.C.A. Technical Note No. 122 - 1923.

3. Munk, Max M. : Preliminary Wing Model Tests in the Variable Density Wind Tunnel of the National Advisory Committee for Aeronautics. N.A.C.A. Technical Report No. 217 - Appendix - 1925.

Table I.

Ordinates of the N.A.C.A. M-12 Airfoil Section

in Per Cent of Chord.

Sta.	0	1.25	2.5	5.0	7.5	10	15	20
Upper	0.00	2.03	2.86	4.01	4.89	5.59	6.61	7.30
Lower	-0.00	-1.65	-2.14	-2.72	-3.07	-3.31	-3.60	-3.80

Sta.	25	30	40	50	60	70	80	90	95	100
Upper	7.74	7.95	7.86	7.25	6.27	4.98	3.50	1.89	1.07	0.20
Lower	-3.92	-3.98	-3.96	-3.82	-3.50	-3.00	-2.31	-1.37	-0.81	-0.20

Table II.

Airfoil M-12
Average Tank Pressure - 1 atm.
Average Dynamic Pressure - 28.5 kg/m²
Average Reynolds Number - 173,000
Average temperature - 25°C.

Span - 30 in. (76.2 cm)
Chord - 5 in. (12.7 cm)
Aspect Ratio - 6
Date - April 9, 1926.

Angle of attack degrees	Lift Coefficient C_L	Drag Coefficient C_D	Ratio D/L	Moment Coefficient C_M
-3	-.090	.0151	-.168	.030
-1.5	.007	.0128	1.83	.030
0	.104	.0122	.117	.060
1.5	.245	.0135	.055	.050
3	.391	.0189	.048	-.040
4.5	.477	.0234	.049	.030
6	.578	.0317	.055	.010
7.5	.675	.0401	.060	.050
9	.760	.0486	.064	.050
10.5	.828	.0568	.069	.060
12	.899	.0687	.076	.080
13.5	.936	.0817	.087	.100
15	.947	.1020	.108	.100
16.5	.875	.1740	.199	.090
18	.770	.2402	.312	.070
19.5	.730	.2705	.371	.040
21	.721	.3013	.417	.070
22.5	.703	.3253	.463	.110
24	.678	.3496	.517	.120

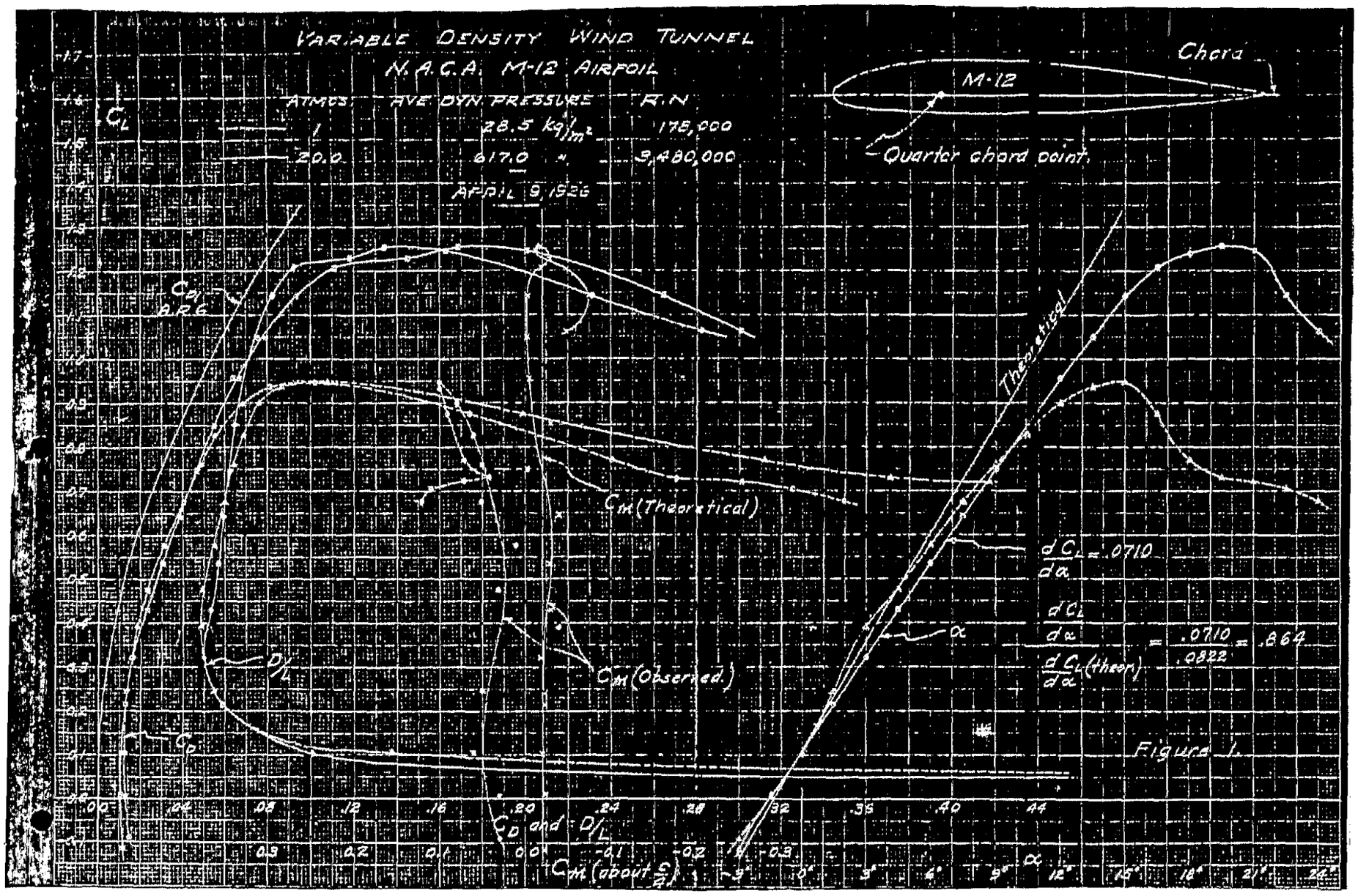
163-2

Table III.

Airfoil M-12
Average Tank Pressure - 20 atm.
Average Dynamic Pressure, q, - 617 kg/m²
Average Reynolds Number - 3,480,000
Average temperature - 40°C.

Span - 30 in. (76.2cm)
Chord - 5 in. (12.7cm)
Aspect Ratio - 6
Date - April 9, 1926.

Angle of attack, degrees	Lift Coefficient C_L	Drag Coefficient C_D	Ratio D/L	Moment Coefficient C_M
-3	-.115	.0119	-.1035	-.022
-1.5	.010	.0103	1.030	-.024
0	.104	.0108	.1039	-.020
1.5	.214	.0129	.0603	-.023
3	.320	.0159	.0497	-.018
4.5	.430	.0231	.0537	-.030
6	.536	.0304	.0567	-.029
7.5	.643	.0382	.0594	-.039
9	.749	.0466	.0622	-.002
10.5	.852	.0549	.0644	-.030
12	.956	.0640	.0669	-.005
13.5	1.050	.0794	.0756	-.002
15	1.142	.0940	.0823	-.003
16.5	1.208	.1114	.0922	-.019
18	1.228	.1449	.1180	-.029
19.5	1.253	.1684	.1344	-.019
21	1.245	.2026	.1627	-.013
22.5	1.142	.2643	.2314	-.075
24	1.061	.3001	.2831	-.048


VARIABLE DENSITY WIND TUNNEL
N.A.C.A. M-12 AIRFOIL
ATMOS. AVE. DYN. PRESSURE R.N.
1 28.5 kg/m² 178,000
20.0 617.0 " 3,480,000
APRIL 9, 1926
Chord
M-12
Quarter chord point
C_L
C_{D_1} A.R.6
C_M (Theoretical)
C_M (Observed)
D/L
C_D
C_D and D/L
C_M (about $\frac{c}{4}$)
Theoretical
$\frac{dC_L}{d\alpha} = .0710$
$\frac{dC_L}{d\alpha} / \frac{dC_L}{d\alpha}$ (theor) $= \frac{.0710}{.0822} = .864$
α
Figure 1.