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NAVY DEPARTMENT
DAVID TAYLOR MODEL BASIN
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CHARACTERISTIC CURVES FOR PLANING SURFACES

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PERSONNEL

This memorandum is the work of L. Landweber and P. Eisenberg.

CHARACTERISTIC CURVES FOR PLANING SURFACES

The results of an extensive series of tests of planing surfaces are given in the N.A.C.A. Technical Note 509, "Tank Tests of Flat and V-Bottom Planing Surfaces," by James M. Shoemaker, November 1934. The data are presented as curves of resistance, position of center of pressure, and wetted length against speed for various parametric values of the load and trim angle. The data are also expressed in dimensionless form for the trim angle of minimum resistance for each planing surface tested.

While this work has proved itself of great value in the preliminary design of planing surfaces, it has been not easy to apply in problems involving the towing of a planing float. The reason for this is that in general the towline attached to such a float will exert a downward pull, varying with speed, whose magnitude may be the greatest part of the total load on the water. Consequently Shoemaker's curves of constant load will be difficult to apply.

To obtain curves of more general value, the load-drag ratio, L/D, and a load coefficient, C_L, were computed from the original data.

Here L is the total load in pounds

D is the float resistance in pounds

$$C_L = \frac{2L}{\rho a b v^2}$$

ρ is the density of water in slugs per cubic foot

a is the distance of the center of pressure from the stern, in feet

b is the beam of the float in feet

v is the speed of the float in feet per second

These quantities are illustrated by the diagram in Figure 1 of one of the planing surfaces of the referenced report.

The computed values were then plotted as C_L on a basis of the ratio a/b for various values of the trim angle. It was found that at a given trim angle the plot

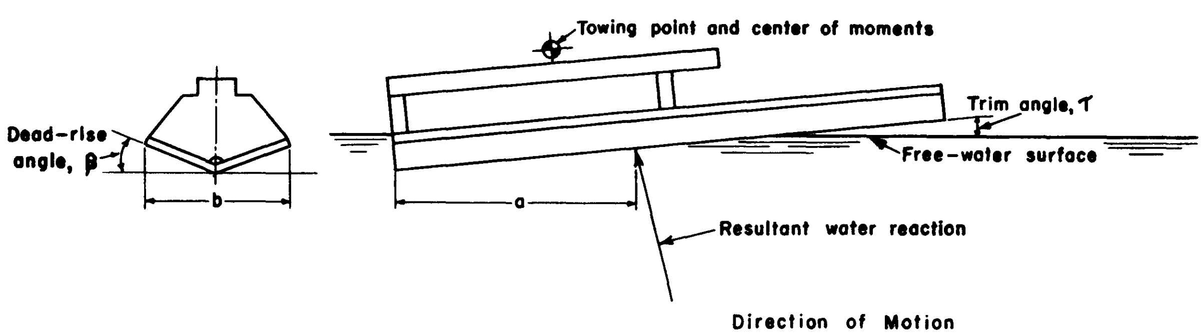

Figure 1 - Diagram of Planing Surfaces

of C_L against a/b could be represented closely by a single curve, except at very low values of C_L. These anomalous data, which will be discussed subsequently, were omitted from the plots. The remaining spots were cross-faired and then replotted as C_L against trim angle for various values of the ratio a/b. The values of L/D were plotted, cross-faired, and replotted in a similar way. The results are given in Figures 2, 3, 4, and 5.

As plotted, the data are presented in terms of only one parameter, a/b, instead of the two required when plotted as original data. The form of the new plot is similar to that used in presenting characteristic curves of an airfoil.

As an illustration of the use of the new curves, consider a planing float of 10-degree dead rise, 5-foot beam, weighing 4000 pounds, with its center of gravity 5 feet from the stern. Then

$$C_L = \frac{2 \times 4000}{1.99 \times 25 \times v^2} = \frac{161}{v^2}$$

and $a/b = 1.0$. The drag for any speed can now be computed from the figure for 10-degree dead rise. Thus when v is 50 feet per second, about 30 knots, $C_L = 0.0644$, $L/D = 7.34$, and hence $D = 545$ pounds.

Now suppose the center of gravity to be shifted to 7.5 feet from the stern. Then $C_L = 0.0429$, $a/b = 1.5$, and hence $L/D = 6.6$, and $D = 606$ pounds.

The scattering of the data at the very low values of C_L mentioned in the foregoing corresponds to the behavior of planing surfaces when run at high speeds under small loads, such as small, high-speed racing boats. Shoemaker's original data show that under these conditions the wetted length of the planing surface may be actually less than the distance a of the center of pressure from the stern. This can be the case only when the pressures along the wetted length become negative towards the stern. This effect has been noted also by J. Plum, in an unpublished paper entitled "On the Weight-Carrying Hydroplane Boat."

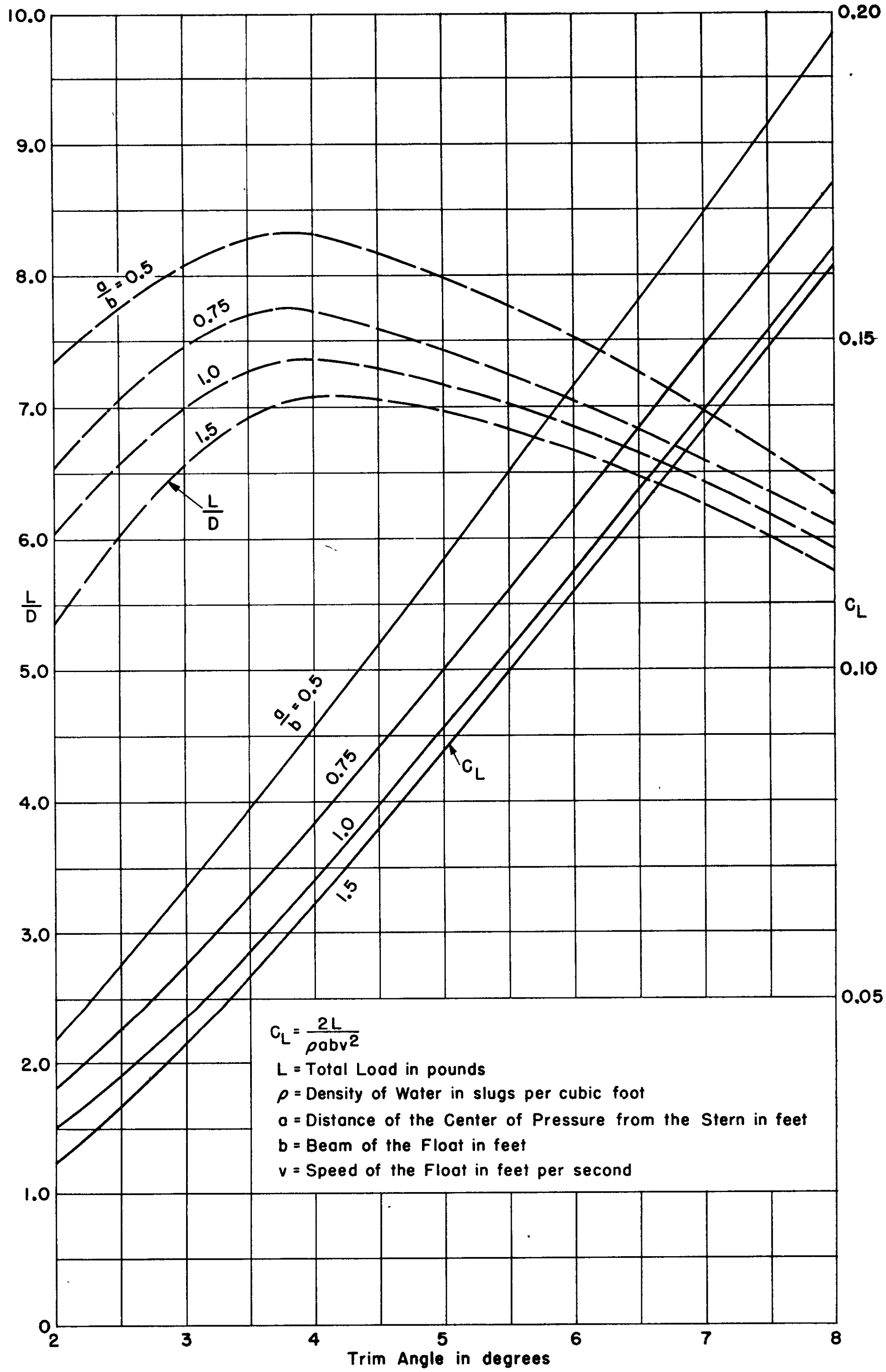

Figure 2 - Characteristic Curves for Planing Surfaces

0 degrees Dead Rise

Computed from data in N.A.C.A. Technical Note 509
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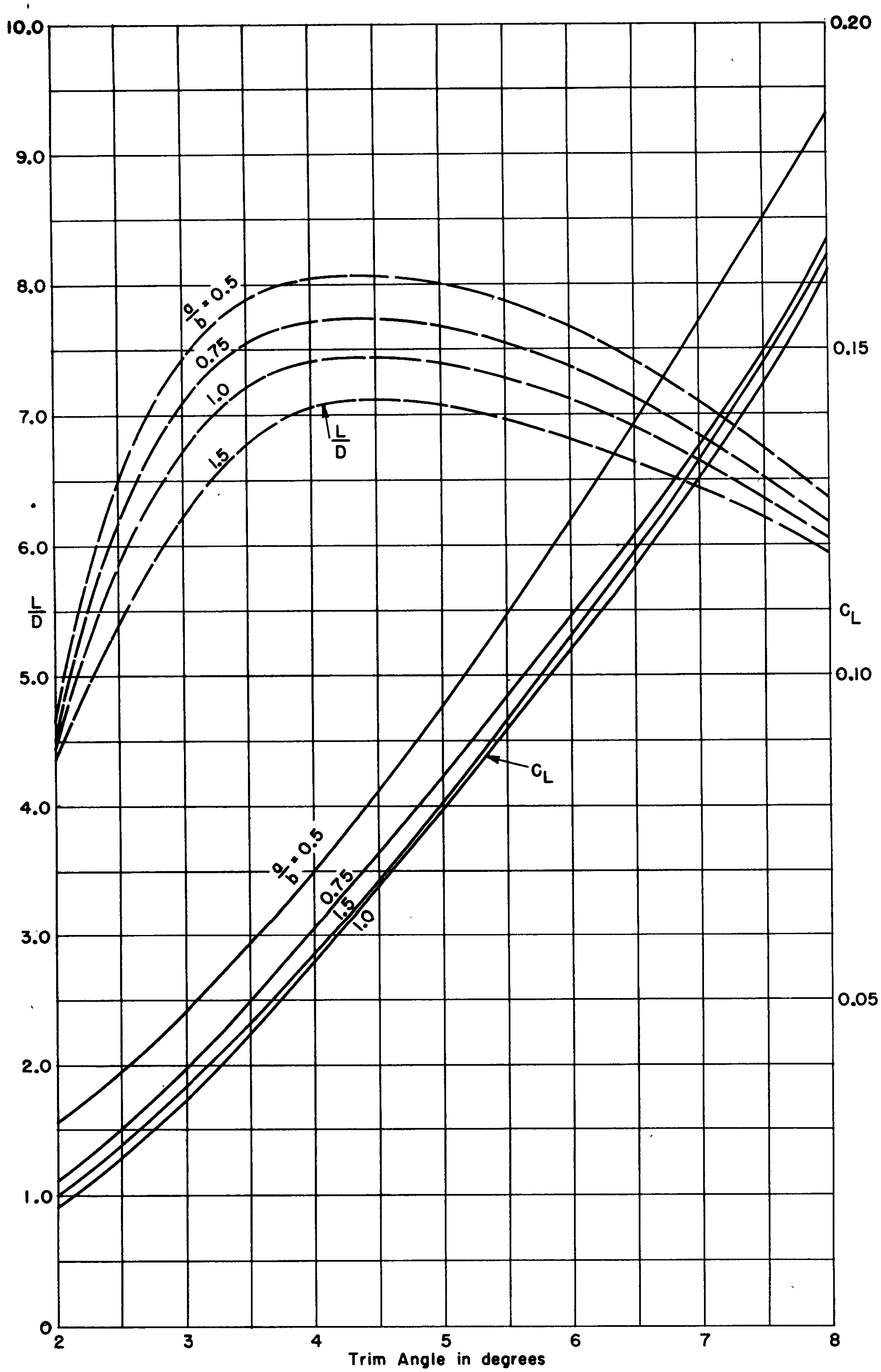

Figure 3 - Characteristic Curves for Planing Surfaces
10 degrees Dead Rise

Computed from data in N.A.C.A. Technical Note 509
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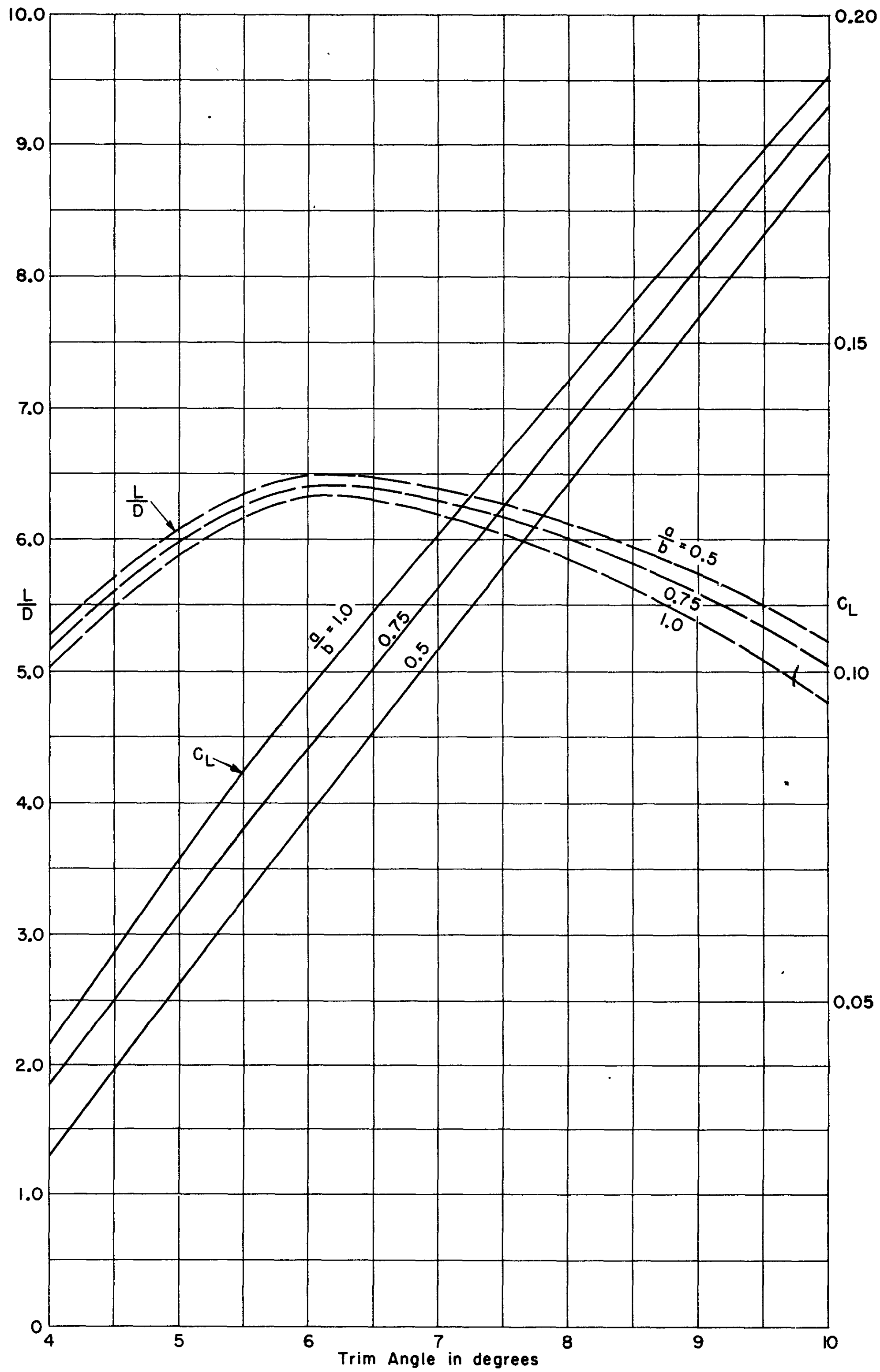

Figure 4 - Characteristic Curves **for Planing Surfaces**

20 degrees Dead Rise

Computed from data in N.A.C.A. Technical Note 509
"Tank Tests of Flat and V-Bottom Planing Surfaces," by James M. Shoemaker

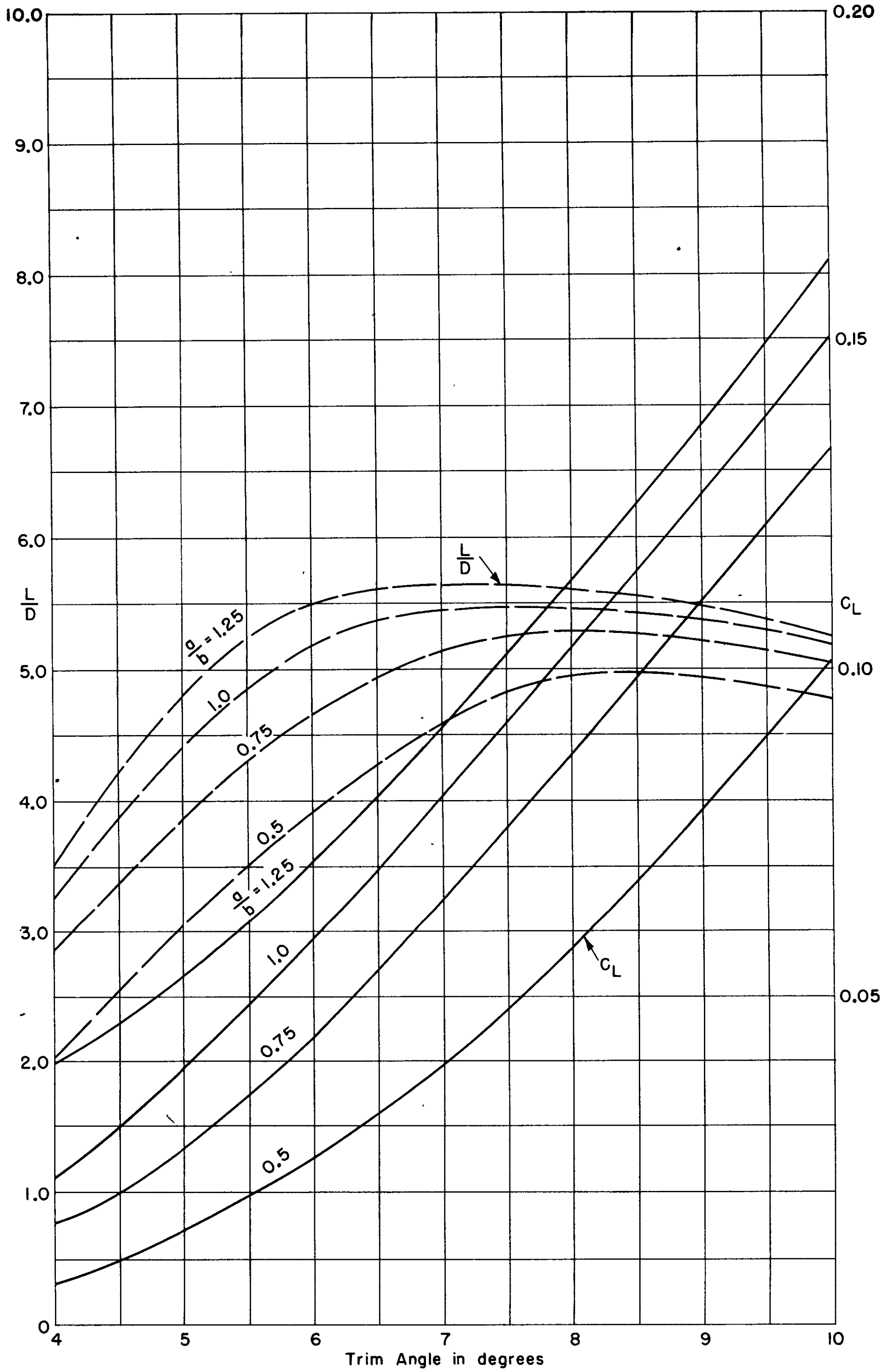

Figure 5 - Characteristic Curves for Planing Surfaces

30 degrees Dead Rise

Computed from data in N.A.C.A. Technical Note 509
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