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Tests on a 'Glauert' Nose-suction Aerofoil in the N.P.L. 4-ft. No. 2 Wind Tunnel

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Summary.—Tests on an 8·65 per cent thick nose-suction aerofoil designed by Glauert have been made in the 4-ft No. 2 wind tunnel at the National Physical Laboratory at Reynolds numbers 0·385 and $0 \cdot 577 \times 10^6$. The results show that the section stalls at a lift coefficient of 1·13 without suction.* With suction quantities of 0·003, 0·0045, 0·006 and (with a wider slot) 0·012, the values of $C_{L\ \max.}$ were respectively 1·32, 1·34, 1·36 and 1·57.

1. *Introduction.*—Following a suggestion by Goldstein and Richards, Lighthill[1] designed a number of aerofoil sections on which separation from the upper surface at high incidences could be suppressed by means of a sink at the nose, so that a higher maximum lift might be obtained than with conventional sections of the same thickness. One of these sections, 8·6 per cent thick, was tested in the National Physical Laboratory 4-ft No. 2 wind tunnel[2], and gave a maximum C_L of the order of 1·9 with suction quantity coefficient C_Q equal to 0·019. Unfortunately this suction quantity is rather high for practical application. To reduce it, Glauert has designed a number of sections with a small slot at a short distance from the nose on the upper surface. It was intended that, at design C_L, the velocity over the surface should increase from the stagnation point up to the slot entry, with a second stagnation point on the upper lip of the slot and a moderate adverse gradient behind it on the upper surface. This paper describes tests made on one of these sections, which is 8·65 per cent thick. Its design is described in Appendix II of Ref. 3.

2. *The Aerofoil.*—The section of the aerofoil tested is shown in Fig. 1. The thickness of the trailing edge was increased to avoid difficulties in the construction and the slot was made 0·020 in. thick, as shown in the enlarged drawing, for the same reason. The chord of the model was 18 in., and it spanned the 4-ft No. 2 tunnel horizontally. The ducting inside the aerofoil was identical with that used in the Lighthill aerofoil[2], the slot leading downwards and backwards and expanding rapidly into the original forward-facing entry. The external ducting was also the same as used for the Lighthill aerofoil, with the addition of 1¼ in. diameter calibration tubes, to measure the smaller suction quantities.

The roof and floor of the tunnel were set to give zero static pressure drop down the centre of the empty tunnel.

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* Throughout this report, no correction has been applied for tunnel interference. At low incidence the lift constraint correction would reduce the lift coefficients by about 6%.

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3. *Results.*—3.1 *Suction Distribution.*—The spanwise distribution of the suction flow into the slot was measured by means of a backward-facing tube inserted a short distance into the slot. The distribution of velocity, shown in Fig. 2, indicates that the flow is reasonably uniform.

3.2 *Tests Without Suction.*—The wing was tested at 40 and 60 ft/sec ($R = 0 \cdot 385$ and $0 \cdot 577 \times 10^6$) over a range of incidence. The lift curve is shown in Fig. 3*a*. The maximum lift coefficient attained was 1·13.

3.3 *Tests With Suction.*—The theoretical suction coefficient C_Q (suction quantity per foot span/free-stream velocity × chord) to give the designed velocity into the slot (4 times free-stream velocity) is 0·0044. The wing was therefore tested at values of C_Q of 0·003, 0·0044, and 0·006, at 60 and 40 ft/sec. The lift curves obtained varied very little; the wing began to stall at 12—13 deg incidence ($C_L = 1 \cdot 3$) for all three suction quantities; above this incidence the readings fluctuated, with a slight increase in lift. One curve is shown in Fig. 3. The slot width was later increased to 0·04 in.; a quantity coefficient of 0·012 then gave a maximum C_L of 1·57.

3.4 *Velocity Distribution.*—The velocity distribution over the aerofoil is shown in Figs. 4 to 6.

4. *Conclusions.*—Suction quantity coefficients between 0·003 and 0·006 increased the stalling C_L of this aerofoil from 1·13 to about 1·35; within this range, the stalling C_L did not vary greatly. With a suction quantity coefficient of 0·012, the stalling C_L rose to 1·57; the considerable increase was probably due in part to sink effect.

Acknowledgments.—Grateful acknowledgments are due to Engineering Division, N.P.L., for the loan of the pump and motor.

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2.	F. Cheers, W. G. Raymer, *and* Ola Douglas	Tests on a 'Lighthill' Nose-suction Aerofoil in the N.P.L. 4-ft No. 2 Wind Tunnel. R. & M. 2355 (April, 1947).
3.	J. Williams	A Comparison of the Stalling Properties of some Thin Nose-suction Aerofoils. A.R.C. 11560 (June, 1948).

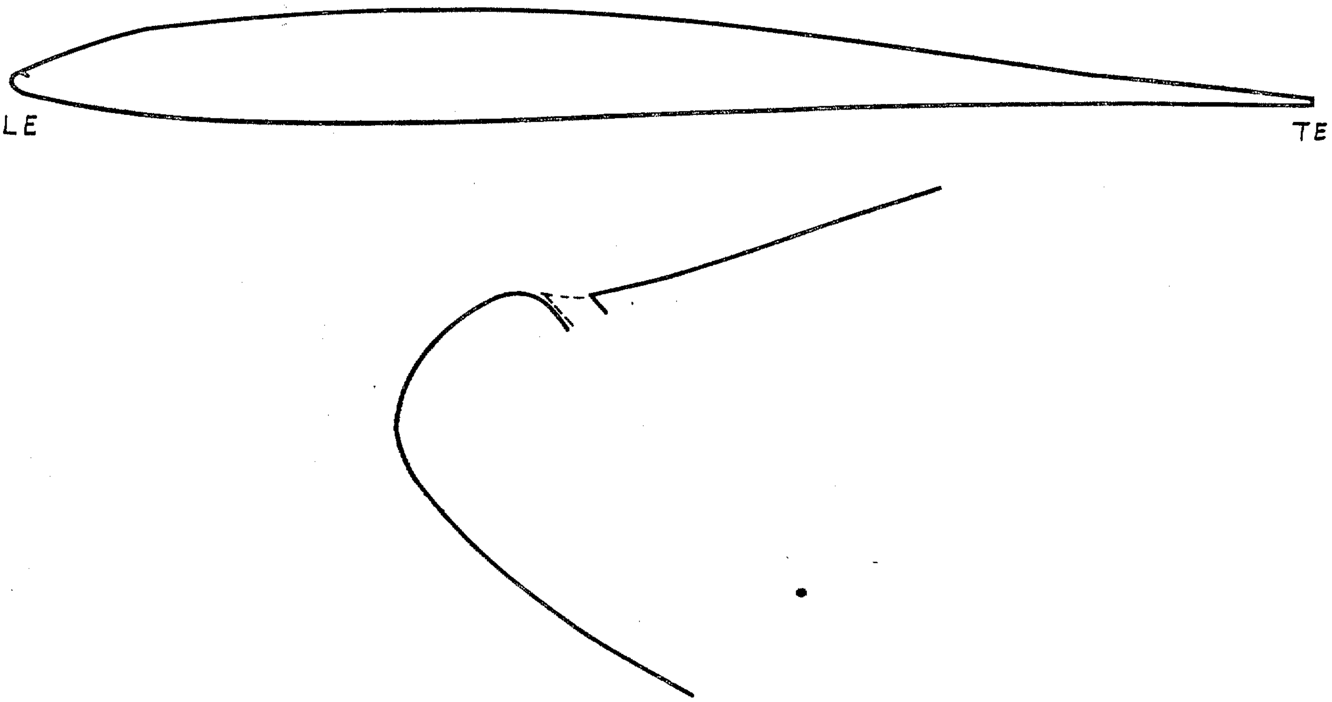


FIG. 1. Section of aerofoil as tested, with enlarged view of nose showing actual slot (full lines) and theoretical slot (dotted).

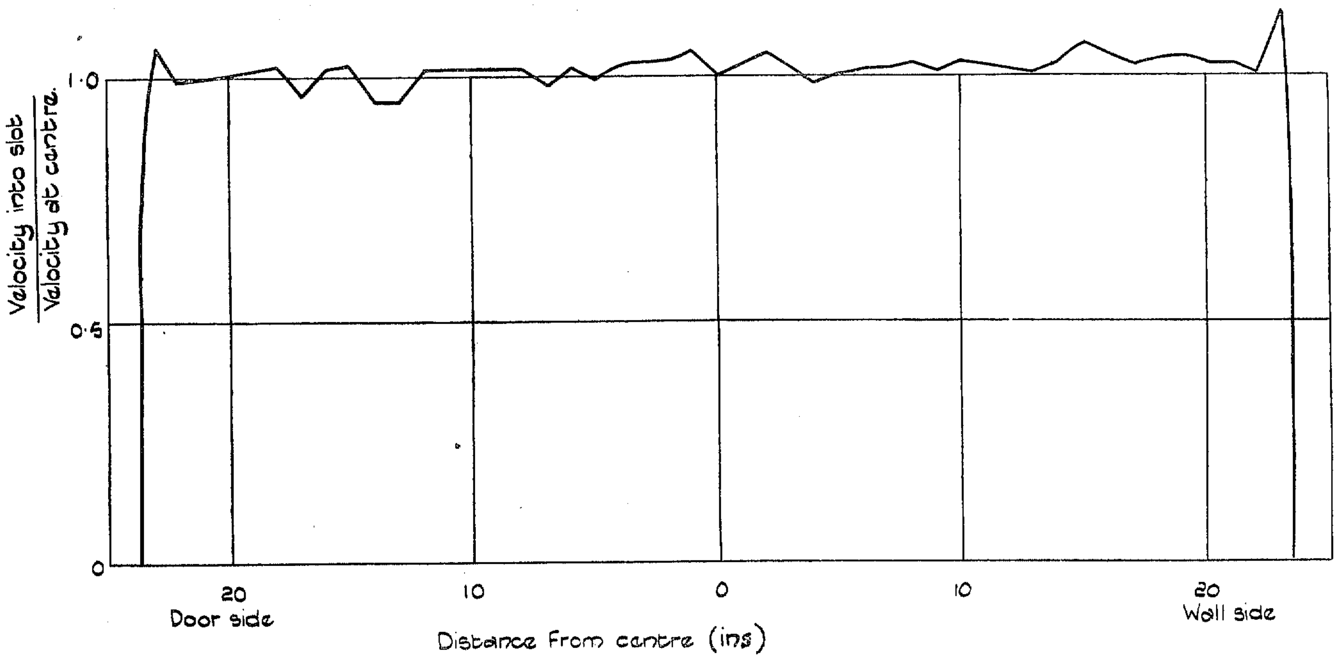
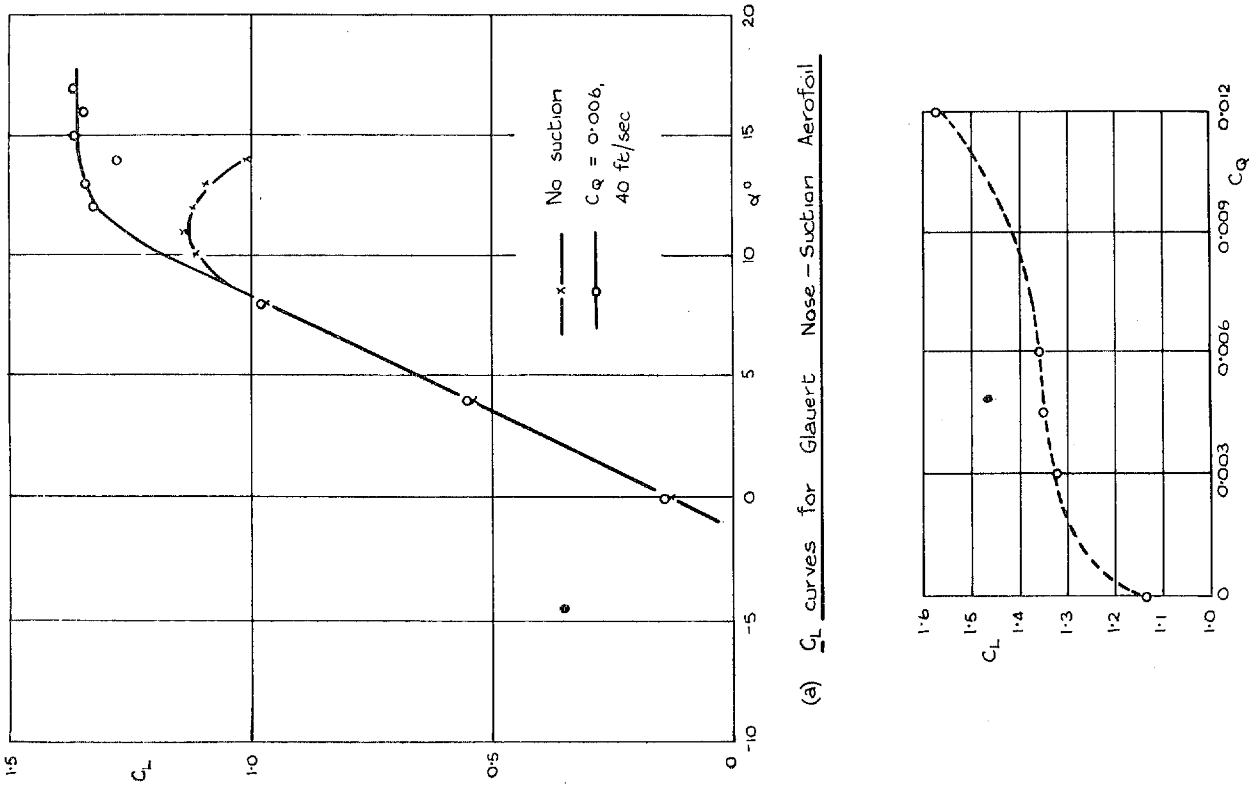


FIG. 2. Spanwise distribution of velocity into slot.



(a) C_L curves for Glauert Nose-Suction Aerofoil

(b) Variation of C_L at stall with suction quantity

FIG. 3.

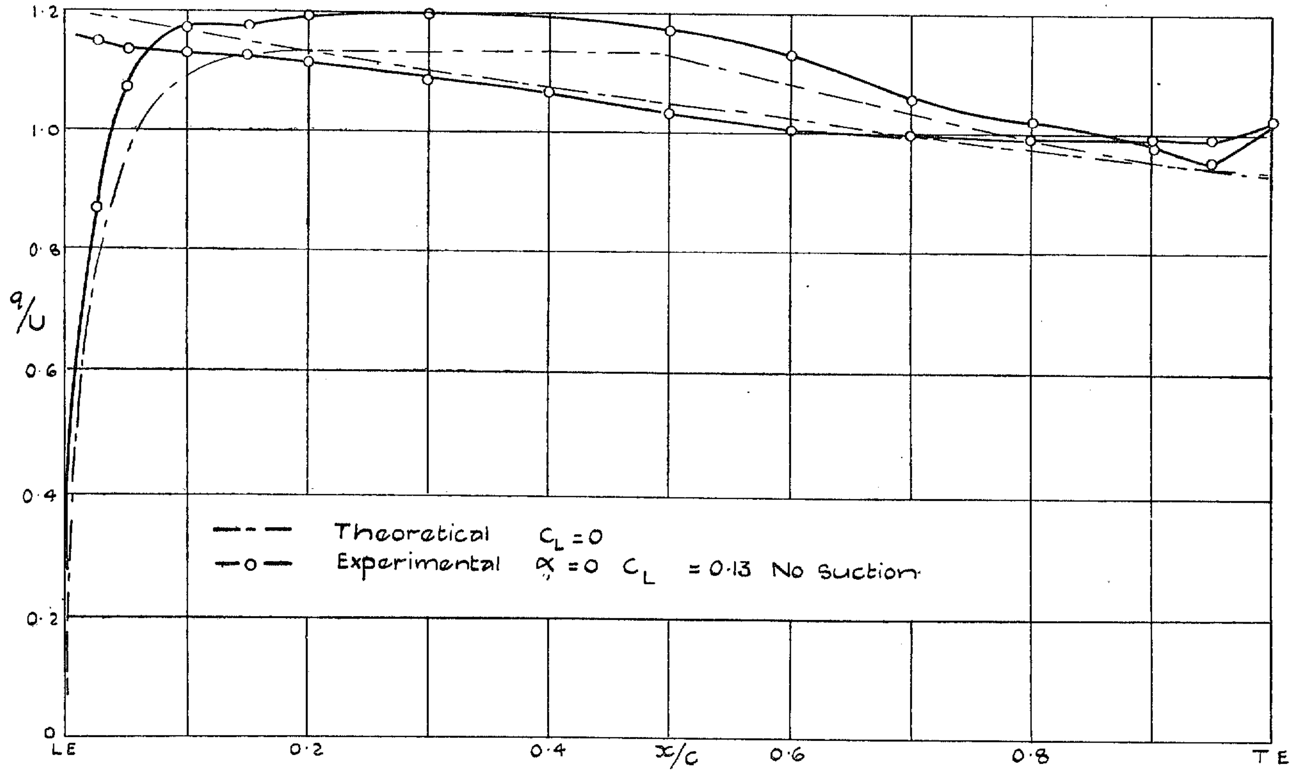


FIG. 4. Velocity distribution over aerofoil at 60 ft/sec.

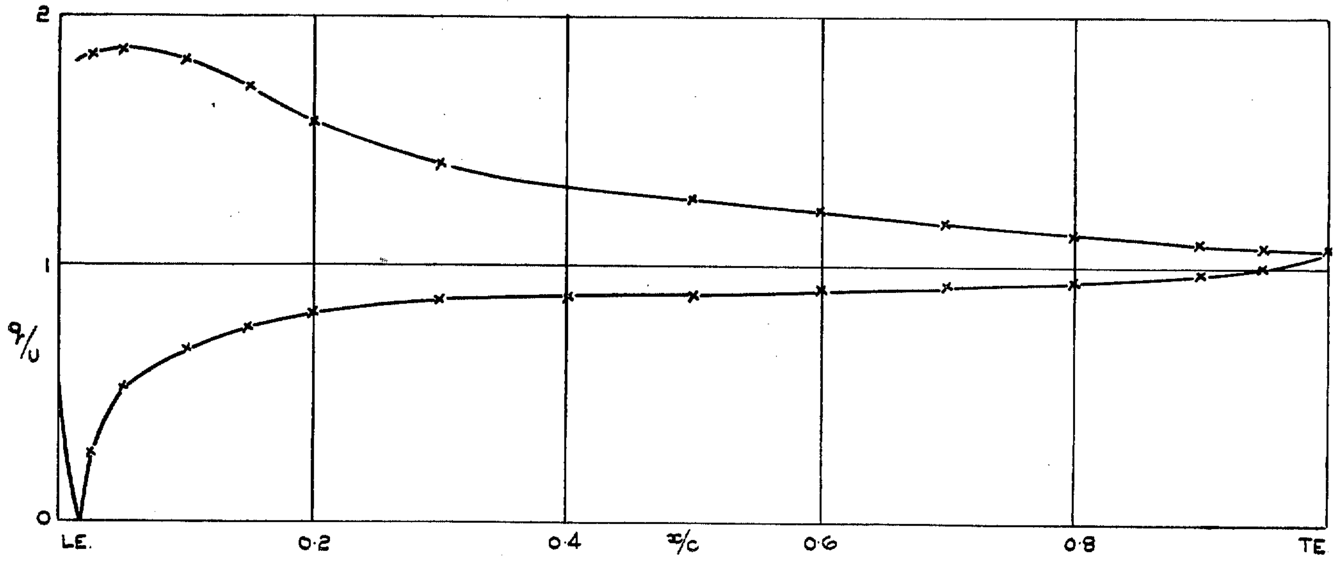


FIG. 5. Velocity distribution over aerofoil at 60 ft/sec. $\alpha = 10$ deg. $C_L = 1\cdot10$. No suction.

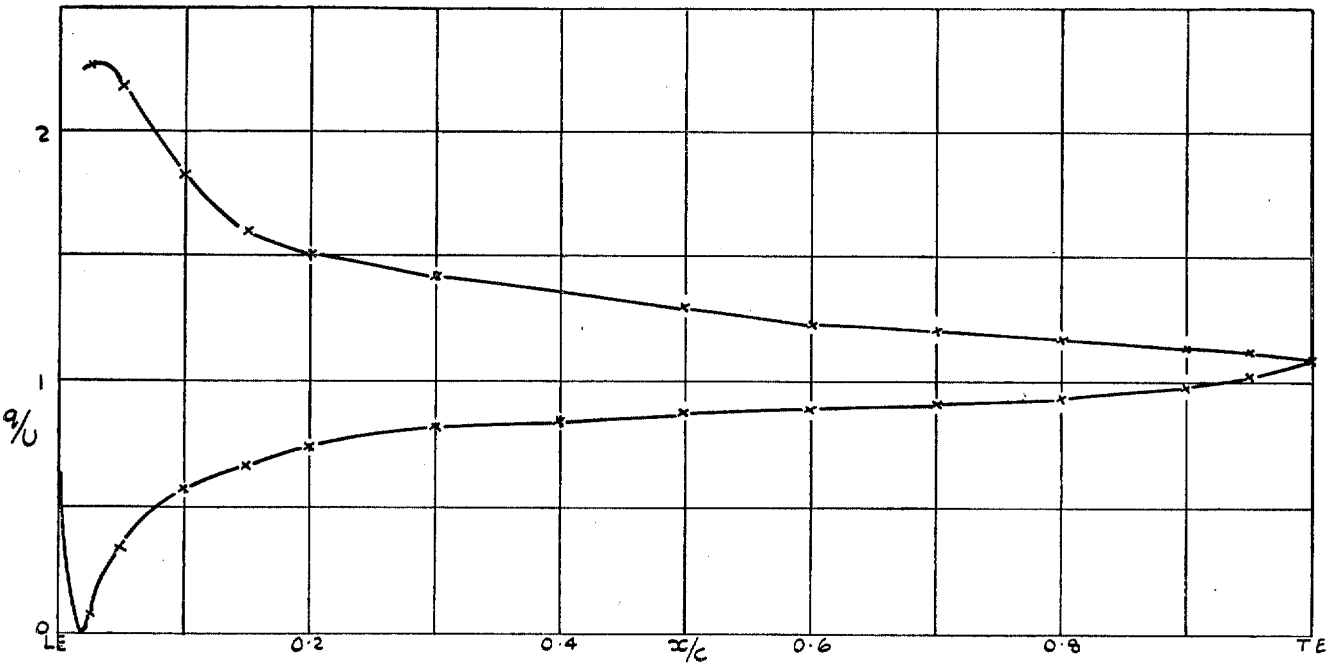


FIG. 6. Velocity distribution over aerofoil at 60 ft/sec. $\alpha = 13$ deg. $C_L = 1\cdot25$. $C_Q = 0\cdot0044$.

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