THE SLOW STEADY MOTION OF LIQUID PAST A SEMI-ELLIPTICAL BOSS

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1. Introduction. In this problem of two-dimensional viscous flow, liquid is supposed to have a rigid boundary represented by *ABCDE* in Figure 1 and, apart from the disturbance caused by the presence of the elliptical boss *BCD*, is assumed to be in uniform shearing motion. The stream function is thus a biharmonic function vanishing together with its normal derivative at all points of the boundary, and proportional to y^2 at a great distance from the boss. A series of functions is found, each of which satisfies all the boundary conditions save one. A linear combination of these functions will also satisfy the boundary conditions with this one exception, and by a particular choice of the arbitrary constants which it contains, the remaining condition can be satisfied at as many points as desired. Special cases are discussed, and a process of approximation is outlined which yields the most accurate results at C, and also gives a convenient function for determining at any point of the boundary the magnitude of the error in the unsatisfied boundary condition. A special case of this problem has previously been considered [1].

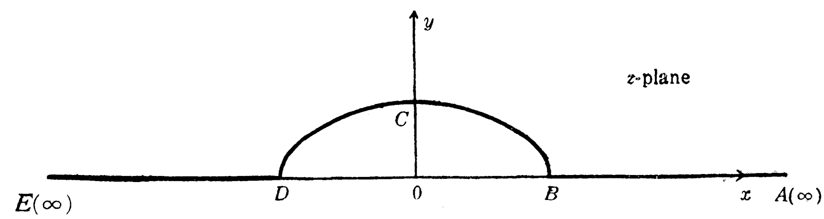

Figure 1.

2. The stream function. We take the equation of the boundary *BCD* to be $x^2/a^2+y^2/b^2=1$, and note that the region occupied by the fluid, for which y is never negative, is transformed into the interior of the semi-circle of unit radius shown in Figure 2 by

$$-2z=(a-b)w+(a+b)/w\ . \tag{1}$$

The stream function ψ is biharmonic, that is to say it must satisfy $\nabla^4\psi=0$, and a satisfactory solution to the problem is

$$\psi=y^2+U+yV\ , \tag{2}$$

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