Problem 3.05
This problem is from “Advanced Fluid Mechanics Problems” by A.H. Shapiro and A.A. Sonin

A long, flat plate of breadth $L$ ($L$ being small compared with the length perpendicular to the sketch) is hinged at the left side to a flat wall, and the gap between the plate and wall is filled with an incompressible liquid of density $\rho$. If the plate is at a small angle $\theta(t)$ and is depressed at an angular rate

$$\omega(t) = -\frac{d\theta}{dt},$$

obtain an expression for the average liquid speed $u(x, t)$ in the $x$-direction at station $x$ and time $t$. 