ESO212: Clarification on Source Strength in Potential Flows

Notation in my lecture

In my lecture, we considered a *line source* of length b from which fluid is constantly coming out with volumetric flow rate Q. If we align the source with the z axis of a cylindrical coordinate system, then the volumetric flow rate Q at a distance r from the z axis is given by

$$Q = 2\pi r b v_r$$

where v_r is the velocity in the r direction. There is no velocity in the z-direction as well as θ direction due to symmetry. We can re-write the above equation as

$$v_r = \frac{Q}{2\pi r b}$$

If we *define* $m \equiv Q/(2\pi b)$ (or $Q = 2\pi m b$) then

$$v_r = \frac{m}{r}$$

where we defined m as the source strength in the lecture.

Gupta & Gupta notation

In the textbook of Gupta & Gupta (page 335, second edition), they considered a line source of length $b = 1$ (unit length). But to be consistent with the above discussion, let us consider the source length to be b, which we can finally set to 1. The volumetric flow rate at a distance r from the z axis is again $q = 2\pi r v_r b$. Gupta & Gupta use q for volumetric flow rate. They *define* $A = q/(2\pi)$ and write $v_r = \frac{q}{2\pi r b}$ with b set to 1 as:

$$v_r = \frac{q}{2\pi r}$$

If they had chosen to write this using the definition of A they would also have

$$v_r = \frac{A}{r}$$

So, the A defined in Gupta & Gupta is equivalent to the m defined in the lecture. However, they do not use A, but simply write it as $v_r = q/(2\pi r)$. Thus, the discussions in the lecture and Gupta & Gupta are consistent.