11. A rectangular shaft has a cross section with a width of $b = 15$ mm and a thickness of $t = 6$ mm shown in the figure. It is designed to transimit a torque $T \sim N(10, 1^2)$ N·m. The shear modulus is $G \sim N(80,10^2)$ GPa. If the allowable angle of twist is $\theta_a = 5 \times 10^{-2}$ and the proability of failure is designed to be $p_f = 10^{-5}$, determined the maximum length of the shaft. Note that $T$ and $G$ are independent.

**Answer:** $l = 175.60$ mm, $l_{preferred} = 160$ mm