We need $b\,(b^2+k)^{\frac{3}{2}}$ in terms of Θ_s. Since $\left(1-\frac{\Theta_s}{\pi}\right) = \frac{b}{(b^2+k)^{\frac{1}{2}}}$,

$$\left(1-\frac{\Theta_s}{\pi}\right)^3 = \frac{b^3}{(b^2+k)^{\frac{3}{2}}} \Rightarrow \boxed{b\,(b^2+k)^{\frac{3}{2}} = \frac{b^4}{\left(1-\frac{\Theta_s}{\pi}\right)^3}}$$

We also have

$$b^2 = (b^2+k)\left(1-\frac{\Theta_s}{\pi}\right)^2$$

$$\Rightarrow b^2\left[1-\left(1-\frac{\Theta_s}{\pi}\right)^2\right] = k\left(1-\frac{\Theta_s}{\pi}\right)^2 \Rightarrow b^4 = \frac{k^2\left(1-\frac{\Theta_s}{\pi}\right)^4}{\left[1-\left(1-\frac{\Theta_s}{\pi}\right)^2\right]^2}$$

$$\Rightarrow \sigma = \frac{1}{\pi k}\,\frac{1}{\sin\Theta_s}\,\frac{k^2\left(1-\frac{\Theta_s}{\pi}\right)^4}{\left[1-\left(1-\frac{\Theta_s}{\pi}\right)^2\right]^2}\,\frac{1}{\left(1-\frac{\Theta_s}{\pi}\right)^3} = \frac{k}{\pi}\,\frac{1}{\sin\Theta_s}\,\frac{\left(1-\frac{\Theta_s}{\pi}\right)}{\left(\frac{2\Theta_s}{\pi}-\frac{\Theta_s^2}{\pi^2}\right)^2}$$

Putting in value for k $\Rightarrow$

$$\boxed{\begin{aligned} \sigma &= \frac{k}{m v_0^2}\,\frac{(1-x)}{x^2(2-x)^2\sin\pi x}\,\frac{1}{\pi} \\ \sigma(\Theta)\,d\Theta &= \frac{k}{2E}\,\frac{(1-x)\,dx}{x^2(2-x)^2(\sin\pi x)} \end{aligned}}$$

with $x = \frac{\Theta_s}{\pi}$, $m v_0^2 = 2E$

$$\frac{d\Theta_s}{\pi} = dx$$

Which agrees with Goldstein.