Suppose

$$\rho(z) = \begin{cases} 0, z<0 \\ g(z), 0 \le z<l \\ 0, z \ge l \end{cases}$$

Therefore, we have

$$E = \begin{cases} 0, z < 0 \\ \int_0^z \frac{\rho(z)}{\varepsilon_0} dz, 0 \le z \le l \\ \int_0^l \frac{\rho(z)}{\varepsilon_0} dz, z \ge l \end{cases}$$

Then

$$\vec{F} = \int dS \vec{e_n} \int_0^l \rho(z) E dz$$

$$= \int dS \vec{e_n} \int_0^l \rho(z) (\int_0^z \frac{\rho(z')}{\varepsilon_0} dz') dz$$

Suppose

$$T(z) = \int_0^z \frac{\rho(z')}{\varepsilon_0} dz'$$

Then

$$\rho(z) = \frac{dT}{dz}$$

and

$$\vec{F} = \int dS \vec{e_n} \int_0^l \frac{dT}{dz} T(z) dz$$

$$= \frac{1}{2\varepsilon_0} \int dS \vec{e_n} T^2(z) |_0^l$$

$$= \frac{1}{2\varepsilon_0} \int dS \vec{e_n} \left[T^2(l) - T^2(0) \right]$$

$$= \frac{1}{2\varepsilon_0} \int dS \vec{e_n} T^2(l)$$

$$= \frac{\sigma^2}{2\varepsilon_0} \int dS \vec{e_n}$$

.QED