i) a) Linear $\Rightarrow \rho = a + bz$

$z = h \Rightarrow \rho = \rho_w$

$z = 0 \Rightarrow \rho = \rho_s$

$\therefore a = \rho_s$

and $\rho_w = \rho_s + bh$

$\therefore b = \frac{\rho_s - \rho_w}{h}$

so $\rho = \rho_s - \frac{(\rho_s - \rho_w)}{h} z$

b) $dP = (dm)g$ where dm is the mass of water in a layer $1m^2$ of thickness $dh \Rightarrow dm = \rho\, dz$

$\int dP = \int \rho g\, dz = \int \left(\rho_s - \frac{(\rho_s - \rho_w)}{h} z\right) g\, dz$

$\therefore P - P_A = \rho_s g z - \frac{(\rho_s - \rho_w)}{h} \frac{z^2}{2} g$

$P = P_A + \rho_s g(-h) - \frac{g}{2}\left(\frac{\rho_s - \rho_w}{h}\right)(z^2 - h^2)$

c) $dF = P\, dA \Rightarrow F = \int P\, dz$ per unit length

$F = P_A h + \rho_s g\left(-\frac{h^2}{2}\right) - \frac{g}{2}\left(\frac{\rho_s - \rho_w}{h}\right)\left(-\frac{2h^3}{3}\right)$