40. The flat roof (as seen from the air) has area $A = 150 \times 5.8 = 870\,\mathrm{m}^2$. The volume of material directly above the tunnel (which is at depth $d = 60\,\mathrm{m}$) is therefore $V = A \times d = 870 \times 60 = 52200\,\mathrm{m}^3$. Since the density is $\rho = 2.8\,\mathrm{g/cm}^3 = 2800\,\mathrm{kg/m}^3$, we find the mass of material supported by the steel columns to be $m = \rho V = 1.46 \times 10^8\ \mathrm{m}^3$.

(a) The weight of the material supported by the columns is $mg = 1.4 \times 10^9$ N.

(b) The number of columns needed is

$$n = \frac{1.43 \times 10^9\,\mathrm{N}}{\frac{1}{2}\left(400 \times 10^6\,\mathrm{N/m}^2\right)\left(960 \times 10^{-4}\,\mathrm{m}^2\right)} = 75\ .$$