4. In an environment, brass and steel wires of length 1 m each with areas of cross section 1 mm^2 are used. The wires are connected in series and one end of the combined wire is connected to a rigid support and other end is subjected to elongation. The stress required to produce a net elongation of 0.2 mm is,

[Given, the Young's modulus for steel and brass are, respectively, $120\times10^9 N/m^2$ and $60\times10^9 N/m^2$]

[10 April 2019 II]

(a) $1.2\times10^6\ N/m^2$ (b) $4.0\times10^6\ N/m^2$

(c) $1.8\times10^6 N/m^2$ (d) $0.2\times10^6 N/m^2$

Young modulus, $Y = \dfrac{\text{Stress}}{\left(\dfrac{\Delta l}{L}\right)}$

Let σ be the stress

Total elongation $\Delta l_{net} = \dfrac{\sigma L_1}{Y_1} + \dfrac{\sigma L_2}{Y_2}$

$$\Delta l_{net} = \sigma\left[\frac{1}{Y_1} + \frac{1}{Y_2}\right] \quad [\because L_1 = L_2 = 1\text{m}]$$

$$\sigma = \Delta l\left(\frac{Y_1 Y_2}{Y_1 + Y_2}\right)$$

$$= 0.2 \times 10^{-3} \times \left(\frac{120 \times 60}{180}\right) \times 10^9 = 8 \times 10^6 \frac{N}{m^2}$$