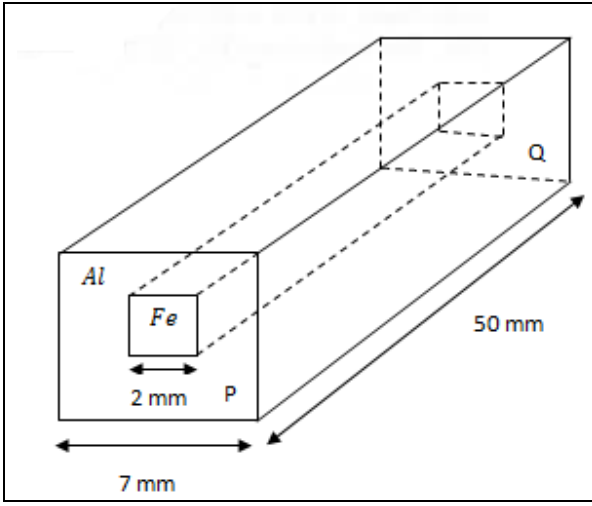
17. In an aluminium (Al) bar of square cross section, a square hole is drilled and is filled with iron (Fe) as shown in the figure. The electrical resistivities of Al and Fe are 2.7×10^{-8} Ω m and 1.0×10^{-7} Ωm respectively. The electrical resistance between the two faces P and Q of the composite bar is



(A) $\frac{2475}{64}\mu\Omega$

(B) $\frac{1875}{64}\mu\Omega$

(C) $\frac{1875}{49}\mu\Omega$

(D) $\frac{2475}{132}\mu\Omega$

Answer: As per the design Aluminium and Iron electrical resistance are connected in parallel, we need to find equivalent resistance.

$R = \rho\frac{l}{A}$

For Aluminium(Al)

$A = 49 - 4 = 45mm^2 = 45 \times 10^{-6}m^2$
$l = 50\ mm = 50 \times 10^{-3}m$
ρ=2.7 × 10^{-8} Ω m

$$R_{Al} = \frac{2.7\ \times\ 10^{-8}\ \times 50 \times 10^{-3}}{45 \times 10^{-6}}$$
$$= 3 \times 10^{-5}\Omega$$

For Iron (Fe)
$A = 4mm^2 = 4 \times 10^{-6}m^2$
$l = 50\ mm = 50 \times 10^{-3}m$
ρ=1.0 × 10^{-7} Ω m

$$R_{Fe} = \frac{1.0\ \times\ 10^{-7} \times 50 \times 10^{-3}}{4 \times 10^{-6}}$$
$$= 12.5 \times 10^{-6}\Omega = 125 \times 10^{-5}\Omega$$

$$R_{eq} = \frac{R_{Al} \times R_{Fe}}{R_{Al} + R_{Fe}} = \frac{3 \times 125}{3 + 125} \times 10^{-5}$$
$$= \frac{3750}{128}\mu\Omega = \frac{1875}{64}\mu\Omega$$

Correct option is (B)