

Q1 (a)

$$Z_w = 1.48 \quad Z_{AL} = 17.3$$

$$\text{At (a)} \quad RE = \left(\frac{1.48 - 17.3}{1.48 + 17.3} \right)^2 \times 100\%$$

$$(a) = \underline{70.96\%}$$

$$(b) = 100 - 70.96 = \underline{29.04\%}$$

Using same %ages;

$$(c) = 29.04\% \times 29.04 = \underline{8.43\%}$$

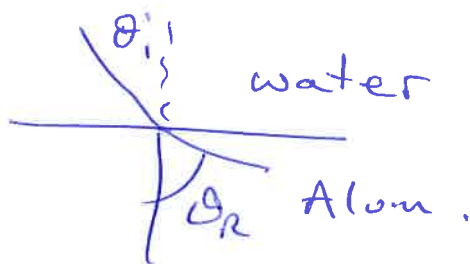
$$(d) = 29.04 - 8.43 = \underline{20.61\%}$$

(you could have also used;
 $70.96\% \times 29.04$)

$$(e) = 70.96\% \times 20.61 = \underline{14.62\%}$$

$$(f) = 20.61 - 14.62 = \underline{5.99\%}$$

(b)



$\theta_r = 45^\circ$
 (compression)

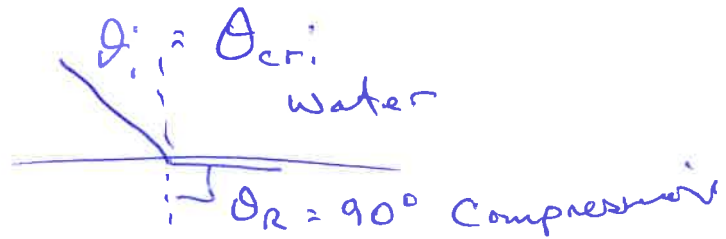
$$\frac{\sin \theta_i}{V_w} = \frac{\sin \theta_r}{V_s}; \quad \theta_i = \sin^{-1} \left[\frac{V_w \sin \theta_r}{V_s} \right]$$

$$\theta_i = \sin^{-1} \left[\frac{1480}{5960} \cdot \sin 45^\circ \right] = \underline{10.11^\circ}$$

(2)

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(d) First critical angle is achieved when $\theta_{R_L} = 90^\circ$.



$$\begin{aligned}\theta_i &= \sin^{-1} \left[\frac{1480}{5960} \sin 90^\circ \right] \\ &= \sin^{-1} \left[\frac{1480}{5960} \times 1 \right] = 14.38^\circ \\ &\quad \text{to 2 dec. places.}\end{aligned}$$

Q 2 (a) PZT Xstal thickness $f_r = 3.5 \text{ MHz}$

$$V_{\text{PZT}} = 3000 \text{ m/s}$$

$$f_r \times t_h = \frac{V}{2}$$

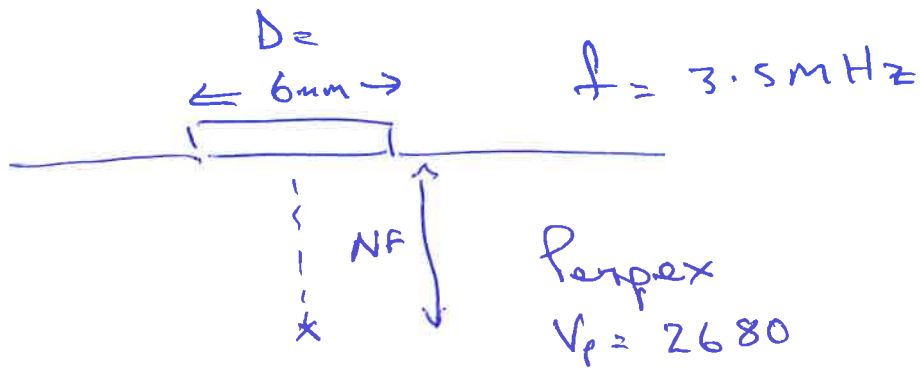
$$t_h = \frac{V}{2f_r} = \frac{3000}{2 \times 3.5 \times 10^6}$$

$$= \frac{3 \times 10^{-3}}{7}$$

$$= 0.43 \text{ mm}$$

3

(b)

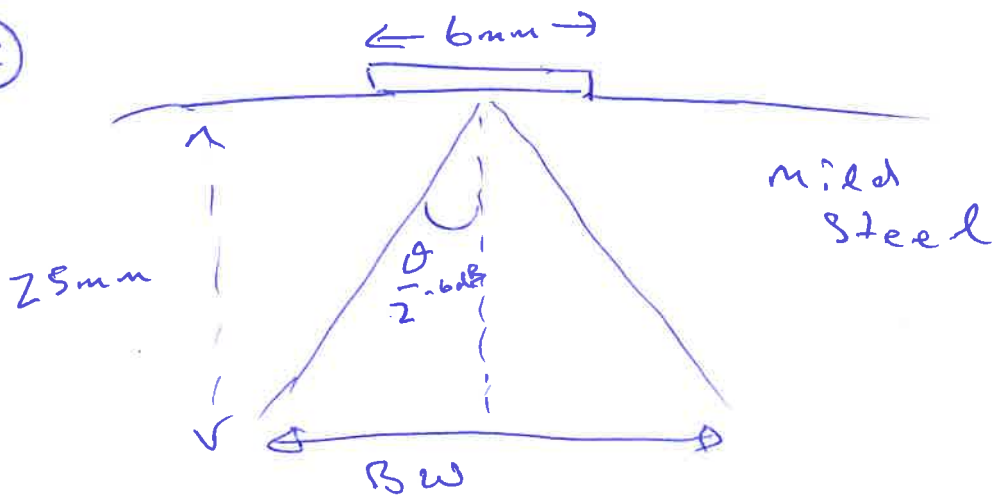


$$NF = \frac{D^2}{4\lambda} ; \quad \lambda = \frac{V}{f} = \frac{2680}{3.5 \times 10^6}$$

$$= \frac{(6 \times 10^{-3})^2}{4 \times (0.766 \times 10^{-3})} = \underline{0.766\text{mm}}$$

$$= \underline{11.75\text{mm}}$$

(c)



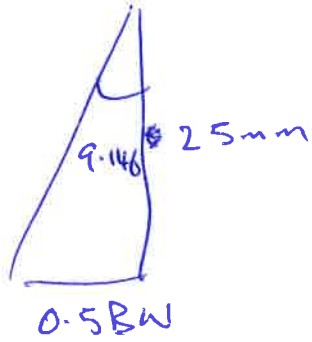
$$\sin \frac{\theta}{2} = \frac{0.56 \lambda}{D} ; \quad \frac{\theta}{2} = \sin^{-1} \left[\frac{0.56 \lambda}{D} \right]$$

$$\lambda_{\text{steel}} = \frac{5960}{3.5 \times 10^6} = 1.703\text{mm}$$

$$\frac{\theta}{2} = \sin^{-1} \left[\frac{0.56 \times 1.703}{6} \right] = \underline{9.146^\circ}$$

(c) cont.

(4)



$$\tan 9.146^\circ = \frac{0.5BW}{25}$$

$$BW = \frac{25 \tan 9.146^\circ}{0.5}$$

$$= 50 \tan 9.146^\circ$$

$$= \underline{8.05 \text{ mm.}}$$
