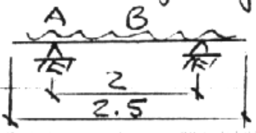
3 c) Consider bending due to uniform distributed load of weight of wall + contents. First have to determine wall thickness. From b) $t = 780/(2 \times 80/2 - 1) = 10$ mm.

weight of wall $\quad w . \pi D_m t = 76.5\pi \times 0.8 \times 0.01 = 1.90$
weight of contents $\quad w \frac{\pi}{4} D_i^2 = 9.81 \frac{\pi}{4} \times 0.78^2 = 4.69$ $\Big\}$ 6.6 kN/m



Max. bending moment at A, or mid-point B

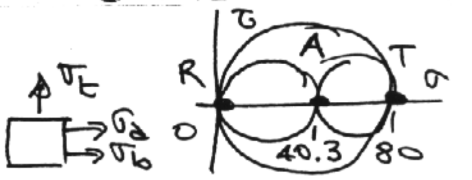
$M_A = 0.25 \times 6.6 \times \frac{0.25}{2} = 0.2$ kNm

$M_B = (\frac{1}{2}\, 6.6 \times 2.5) \times 1 - 1.25 \times 6.6 \times \frac{1.25}{2} = 3.1$ kNm.

So max bending stress, at B, is

$\hat{\sigma}_b = M\hat{y}/I = 3.1 \times 10^3 \times \frac{0.82}{2} / \frac{\pi}{64}(0.82^4 - 0.78^4) = 0.3$ MPa

Superposing bending & membrane does not affect $\hat{\sigma}, \check{\sigma}$ so bending has no effect (MSS)



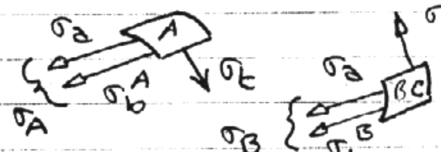
4 $\quad D_i = 86$ mm $\quad \therefore \sigma_t = \frac{p_i D_i}{2t} = 12 \times 86/2 \times 2 = 258$ MPa $\quad ; \quad \sigma_r = 0$

The strains follow immediately from (x)

strains × 10^3		ϵ_t	ϵ_a	ϵ_r	δ_D mm
OPEN	$\sigma_a = 0$	3.69	−1.22	−1.22	0.33
CLOSED	$\sigma_a = \frac{1}{2}\sigma_t = 129$ MPa	3.08	0.63	−1.82	0.28

Increase in diameter $\delta_D = D_o \epsilon_D = D_o \epsilon_t = 90\, \epsilon_t$ (mm).

5. Loading of the pipe is a combination of membrane stresses (σ_t, σ_a) due to pressure, and bending stresses (σ_b). These latter will be different at A and BC – since the neutral axis location is unknown, we shall designate these as σ_b^A and σ_b^B. The (principal) stresses may be found from the strain gauge readings, considering B-C first since two readings are available there, hence σ_t which can then be employed at A, thus:-



$\epsilon_C = (\sigma_t - \nu\sigma_B)/E \qquad 500 \times 10^{-6} = [\sigma_t - 0.3\sigma_B]/207 \times 10^3$

$\epsilon_B = (\sigma_B - \nu\sigma_t)/E \qquad -200 \times 10^{-6} = [\sigma_B - 0.3\sigma_t]/207 \times 10^3$

from which we find $\quad \sigma_t = 100$ MPa and $\sigma_B = -11$ MPa.

Since a closed thin cylinder, $\sigma_a = \frac{1}{2}\sigma_t = 50$ MPa.

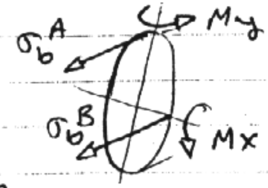
$\therefore \sigma_B = -11 = \sigma_a + \sigma_b^B = 50 + \sigma_b^B \quad$ i.e. $\sigma_b^B = -61$ MPa.

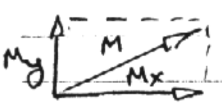
At A: $\quad \epsilon_A = (\sigma_A - \nu\sigma_t)/E \quad \therefore \sigma_A = 800 \times 207 \times 10^{-3} + 0.3 \times 100 = 196$ MPa.

But $\sigma_A = 196 = \sigma_a + \sigma_b^A = 50 + \sigma_b^A \quad$ i.e. $\sigma_b^A = 146$ MPa.

Having got the bending, find the components:

$\sigma_b^A = M_x/Z = 146 \quad$ i.e. $M_x = 146\,Z$
$\sigma_b^B = -M_y/Z = -61 \qquad M_y = 61\,Z$ $\Big\}\ Z = I/\hat{y} = \frac{2I}{D_o}$





The bending moment magnitude is

$M = \sqrt{M_x^2 + M_y^2} = 158\,Z \quad$ i.e. $\hat{\sigma}_b = M/Z = 158$ MPa.

So principal stresses are $0, 100, 158 + 50 \Rightarrow \sigma^* = \underline{208}$ MPa