QUESTION 1

1.1 at 200 mm : $aa + 0\frac{bb_2}{,2} = 25 \times 10^6$ … … … . (1) ✓

: $a - \frac{}{0{,}2^2} = -5 \times 10^6$ bb (2) ✓ at 200 mm… …

(1) + (2) : $2aa = 20 \times 10^6$

$aa = 10 \times 10^6$ ✓

$bb = 600 \times 10^3$ ✓

at 300 mm : $\sigma\sigma_{RR} = aa + \frac{bb}{}0{,}3_2$

$$= 10 \times 10_6 + \frac{600 \times 10_3}{}0{,}3_2$$

$\sigma\sigma_{RR} = 16{,}667$ MPa ✓ (5)

1.2 bb

aat 300 mm : $\sigma\sigma_{HH} = aa - 0\frac{}{,3_2}$

$$= 10 \times 10_6 - \frac{600 \times 10_3}{}0{,}3_2$$

$\sigma\sigma_{HH} = 3{,}333$ MPa ✓ (compressive) ✓ (2)

1.3 bb

$\sigma\sigma_{HH} = 0$ where: $aa - DD\frac{}{xx_2} = 0$

$$^6 - \frac{}{} \; 600DD \times xx_2 10^3 = 0$$

10×10

$$DD_{xx} = 244{,}949 \text{ mm} \checkmark \qquad (1)$$

1.4

at 300 mm : $a + \frac{bb}{0{,}3^2} = 16{,}667 \times 10^6$ ... ... (1) ✓

bb at 300 mm : $a - \frac{}{0{,}3^2} = -65 \times 10^6$ ... ... (2) ✓

$(1) + (2) : 2aa = -48{,}333 \times 10^6$

$aa = -24{,}167 \times 10^6$ ✓

$bb = 3{,}675 \times 10^6$ ✓

at DD : $aa + DD\_\__2 = 0$

$$-24{,}167 \times 10_6 + \frac{3{,}675 \times 10_6}{\_\_\_\_\_} DD_2 = 0$$

$DD = 389{,}9$ mm ✓ (5)

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QUESTION 3

3.1

$$\Delta_1 = \frac{ww\ell_1^4}{8EEEE} + \frac{ww\ell_1^3 \times \ell_2}{6EEEE}$$

$$= 8 \times 200 \frac{10 \times 10^3 \times 2{,}5^4}{} + \frac{10 \times 10^3 \times 2{,}5^3 \times 1{,}5}{} \times 10^9 \times EE + 6 \times 200 \times 10^9 \times EE \checkmark$$

$$\Delta_1 = \frac{439{,}453 \times 10^{-9}}{EE} \checkmark$$

$FFLL^3$ $20 \times 10^3 \times 4^3$ $2{,}133 \times 10^{-6}$

$\Delta_2 = \frac{}{} \quad \frac{}{} \quad \frac{}{} EEEE = 3 \times 200 \times 10_9 \times EE = EE$ ✓

$\Delta_{77} = \Delta_1 + \Delta_2$

$$11 \times 10^{-3} = \frac{439{,}453 \times 10^{-9}}{EE} \quad \frac{2{,}133 \times 10^{-6}}{EE} + \checkmark$$

$$EE = 233{,}89 \times 10^{-6}\ mm^4 \checkmark$$

$$EE = \frac{\pi\pi(DD^4 - dd^4)}{64}$$

$$233{,}89 \times 10^{-6} = \frac{\pi\pi((2dd)^4 - dd^4)}{64} \checkmark$$

$$dd = 133{,}502 \text{ mm} \checkmark$$
$$DD = 267{,}004 \text{ mm} \checkmark$$

(8)

3.2 For $EE = 233{,}89 \times 10^{-6}$ m^4 select $305 \times 305 \times 118$ kg/m ✓ (1)

3.3

$$MM = FFLL + \frac{ww\ell^2}{2}$$

$$M = \frac{}{} \quad \frac{}{} = 20 \times 10^3 \times 4 + 10 \times 10^3 \times 2{,}5^2 \checkmark$$

$$= 111{,}25 \text{ kNm} \checkmark$$

$$\sigma\sigma = \frac{MM}{ZZ} \quad \frac{111{,}25 \times 10^3}{} = 1755 \times 10_{-6} = 63{,}39 \text{ MPa} \checkmark$$

(3)

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QUESTION 5

5.1 $WW_1 = \rho\rho\rho AA\ell = 2200 \times 9{,}81 \times 0{,}5 \times 5 \times bb \times 1 = 53{,}955bb$ kN ✓

$WW_2 = \rho\rho\rho AA\ell = 2200 \times 9{,}81 \times 2 \times 5 \times 1 = 215{,}82$ kN ✓

$VV = WW_1 + WW_2 = 53{,}955bb + 215{,}82$ kN ✓

$$\sigma\sigma_{mmvvxx} = \frac{VV}{BB} + \frac{6VVee}{BB^2} - - - (1) \checkmark$$

$$\sigma\sigma_{mmmmmm} = \frac{VV}{BB} - \frac{6VVee}{BB^2} - - - (2) \checkmark$$

$$(1) + (2):\ 107{,}91 + 35{,}97 = \frac{2VV}{BB} \checkmark$$

$$143{,}88 = \frac{2(53{,}955bb + 215{,}82)}{2 + bb} \checkmark$$

$143{,}88 \times (2 + bb) = 2(53{,}955bb + 215{,}82)$ ✓

$bb = 4$ m ✓ and $BB = 4 + 2 = 6$ m ✓

(10)

5.2 $VV = 53{,}955bb + 215{,}82 = 53{,}955 \times 4 + 215{,}82 = 431{,}64$ kN ✓

$$\sigma\sigma_{dd} = \frac{VV}{BB} = \frac{431{,}64}{6} = 71{,}94 \text{ kPa} \checkmark$$

$\sigma\sigma_{bb} = \sigma\sigma_{mmvvxx} - \sigma\sigma_{dd} = 107{,}91 - 71{,}94$ ✓ $= 35{,}97$ kPa ✓

(4)

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