Answers

1. (b)(i) 70.5 MPa, -7.58 MPa, 39.04 MPa (36.3° clockwise from horizontal axis)

2. (b)(i) [1, 0, -√2, 0, 1, 1, -1, -√2, 0,2]W
   (ii) [-1, -1, √2, √2, -1, -1, 0, 0, 0, 0]W; [0, 0, 0, 0, 0, -1, -1, √2, √2, -1]W
   (iii) [0.45, -0.55, -0.64, 0.78, 0.45, -0.04, -1.49, -0.72, 0.69, 1.51]W

3. (a)(i) 0.065P   (ii) 0.016P
   (b) 2200 N, 2196 N
   (d) -0.56 mm

4. (a) 0.192WL
   (b) 6.66M_P/L

5. (a) H = 6.83M_P/R

6. L/H=0.75

C J Burgoyne
19th June 2009

Numerical answers to Paper 3 (2009)

1.   (c) $\sigma_{xx} = Y\left[1 - \exp\left(\dfrac{\ell - x}{L}\right)\right]$,   where $L = \dfrac{\bar{h}}{\mu + \tan\alpha}$

     (d) $F = 2\bar{h}Y\left[\exp\left(\dfrac{(\mu + \tan\alpha)\ell}{\bar{h}}\right) - 1\right]$

2.   (b)   Fraction of eutectic mix = 0.5
          Weight fraction of α in eutectic mixture = 0.768
          Weight fraction of β in eutectic mixture = 0.232

3.   (b)(ii) $\dfrac{\dot{\tau}\eta}{G_2} + \left(\dfrac{G_1 + G_2}{G_2}\right)\tau = \eta\dot{\gamma} + G_1\gamma$

     (b)(iii) $\gamma = \dfrac{\tau_0}{G_2}$

     (b)(iv) $\gamma = \dfrac{\tau_0}{G_e} - \left[\dfrac{\tau_0}{G_e} - \dfrac{\tau_0}{G_2}\right]\exp\left(-\dfrac{G_1 t}{\eta}\right)$,

          where $\dfrac{1}{G_e} = \dfrac{1}{G_1} + \dfrac{1}{G_2}$

5.   (b)(i)   Requires carbon in the range 0.5 to 1.02 wt%

     (b)(ii)   time = 10.18mins.

     (b)(iii)   peak at $x = 94\,\mu\text{m}$

Answers

Q 3a)   East side at 12.5m and 25m depths N = 1.67 & 2 respectively (open face
        tunnelling is possible)
        West side at 12.5m depth, sand so closed face tunnelling; at 25m depth
        N=16.67 so closed face tunnelling is required

Q 4a) P = 3264 kN/m
  4b) P = 4104 kN/m
  4c) P = 2808 kN/m
  4d) P = 3146 kN/m

Q 5a)   Max BM at the corner = 187 kNm; Max BM at the centre = 533 kNm
  5b) d = 360 mm (including cover)
  5c) A_s = 5919 mm^2/m at the centre; A_s = 1685 mm^2/m
  5d)   no point in double reinforcement as peak BM is not over a short distance and
        the section is already congested.

SPGM