

ENGINEERING TRIPOS PART IIA 2009

MODULE 3D3, STRUCTURAL MATERIALS AND DESIGN

1 (a.i) $8 M_p / L^2$; (a.iii) $12 M_p / L^2$; (b.i) $4 w L^2$; (b.ii) shear force = $w L^2$;
maximum moment = $w L^3 / 2$

2 (a) $h_{\min} = 172 \text{ mm}$; (b) $l_b \geq 16.6 \text{ mm}$; (c) $v_{\text{tot}} = 31.6 \text{ mm}$, $b = 150 \text{ mm}$

3 (a) moment range -243 kNm to 137 kNm ; (b) sagging reinforcement area = 845 mm^2 ;
hogging reinforcement area = 1680 mm^2 ; (c) $V_{\max} = 203.2 \text{ kN}$; (d) $h = 160 \text{ mm}$

4 (a) $M_p = 416.5 \text{ kNm}$, revised M_p after self-weight included = 451.8 kNm ; (b) $M_p = 343.1 \text{ kNm}$, chose a $457 \times 152 \times 60 \text{ UB}$ ($Z_p = 1287 \text{ cm}^3$); reaction components at pinned feet, 147.5 kN and 96.7 kN ; (c) axial force in rafter = 120.8 kN , resulting in 0.5% loss of M_p .