R4 Solution. Grouted cavity retaining wall

The design value of the moment applied,

\[ M_{Ed} = \gamma_{G,sup} G_k + \gamma_Q Q_{k,1} = (1.35 \times 7.9 \times (1.8/3)) + (1.5 \times 4.9 \times (1.8/2)) = 13.01 \text{ kNm} \]

Serviceability limiting span [BS EN 1996-1-1 Table 5.2]

Limiting span to effective depth ratio is 18

Hence effective depth must exceed \( l_{ef}/18 = 1800/18 = 100 \text{ mm} \)

\( f_b \) is the normalised strength of a masonry unit.

For a Group 1 440 x 215 x 100 mm dense aggregate masonry unit

\( f_b = 7 \times 1.38 \times 1 = 9.66 \text{ N/mm}^2 \) [Annex A of BS EN 772-1]

M6 mortar to be used

Characteristic compressive strength of the masonry \( f_k = 0.75(9.66)^{0.7}(6)^{0.3} = 6.3 \text{ N/mm}^2 \)

[Equation 3.1 of BS EN 1996-1-1 and National Annex to BS EN 1996-1-1]

For the higher level of site supervision required for reinforced masonry \( \gamma_m = 2 \)

Design compressive strength of the masonry \( f_d = 6.3/2 = 3.15 \text{ N/mm}^2 \)

\[ Q = \frac{M_{Ed}}{bd^2} = \frac{13.01 \times 10^6}{10^3 \times 165^2} = 0.478 \quad \text{[PD 6697:2010]} \]

\[ Q = 2c (1 - c) f_d = 0.478 \]

\[ 6.3c^2 - 6.3c + 0.478 = 0 \]

\( c = 0.92 \)

Hence lever arm = 0.92 x 165 = 152 mm

\[ A_s = \frac{M_{Rd}}{f_{yd}Z} \]

\( f_{yd} = 500/1.15 = 435 \text{ N/mm}^2 \)

\[ A_s = \frac{13.01 \times 10^6}{435 \times 152} = 197 \text{ mm}^2 \]

Therefore the steel selected is adequate.
Check limit on compressive strength of concrete masonry unit [Equation 6.24 of BS EN 1996-1-1]

\[ M_{Rd} \leq 0.4 f_{d} b d^2 = 0.4 \times 3.15 \times 10^3 \times 165^2 \times 10^{-6} = 34 \text{ kNm} \] Therefore O.K.

Check minimum brick strength required

\[ F_b = 9.66 = \text{brick strength} \times 0.85 \times 1.0 = 11.36 \text{ N/mm}^2 \]

Therefore the brick selected is O.K.

Check shear capacity

Design value of the shear load \( V_{Ed} = 7.9 \times 1.35 + 4.9 \times 1.5 = 18.01 \text{ kN per m run of wall} \)

\[ f_{vd} = \frac{(0.35 + 17.5\rho)}{\gamma_{M}} \quad [\text{Equation J1 of BS EN 1996-1-1}] \]

\[ \rho = \frac{A_s}{b d} = \frac{252}{10^3 \times 165} = 0.0015 \]

\( \gamma_{M} \text{ shear} = 2.0 \)

\[ f_{vd} = \frac{(0.35 + (17.5 \times 0.0015))}{2} = 0.19 \text{ N/mm}^2 \]

\[ V_{Rd} = f_{vd} b d = 0.19 \times 10^3 \times 165 \times 10^{-3} = 31.35 \text{ kN} \]

Therefore the shear resistance is adequate.