R4 Solution. Grouted cavity retaining wall

The design value of the moment applied,
\[ M_{Ed} = \gamma_{G,\text{sup}} G_k + \gamma_Q Q_{k,1} = (1,35 \times 7,9 \times (1,8/3)) + (1,5 \times 4,9 \times (1,8/2)) = 13,01 \text{kNm} \]

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 \( f_d = 6,3/2 = 3,15 \text{ N/mm}^2 \)

\[ Q = \frac{M_{Ed}}{bd^2} = \frac{13,01 \times 10^6}{10^2 \times 165^2} = 0,478 \] [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

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

\( f_{yd} = 500/1,15 = 435 \text{ N/mm}^2 \)

\[ A_s = \frac{13,01 \times 10^6}{435 \times 152} = 197 \text{ mm}^2 \]

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

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

Check minimum brick strength required

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

Therefore the brick selected is O.K.

Check shear capacity

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

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

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

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

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

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

Therefore the shear resistance is adequate.