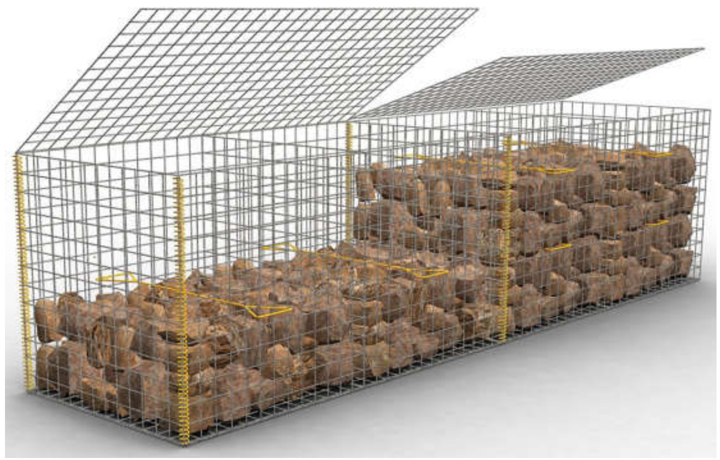
STRUCTURAL ANALYSIS AND DESIGN REPORT FOR A PROPOSED GABION RETAINING WALL

73 Richardson Road, Thornaby TS17 8QE



FEBRUARY 17, 2019

CONSULTING ENGINEERS LTD	PROJECT: PROPOSED RETAINING WALL - THORNABY TS17 8QE				Job Ref.	
	STRUCTURAL CALCULATIONS: GABION RETAINING WALL (RW-1) DESIGN CHECK				Sheet no./rev. 1	
	Calc. by	Date 02/17/2019	Chk'd by	Date	App'd by	Date

GABION RETAINING WALL ANLYSIS & DESIGN

In accordance with BS8002:2015 - Code of Practice for Earth Retaining Structures and the UK National Annex

Tedds calculation version 2.0.01

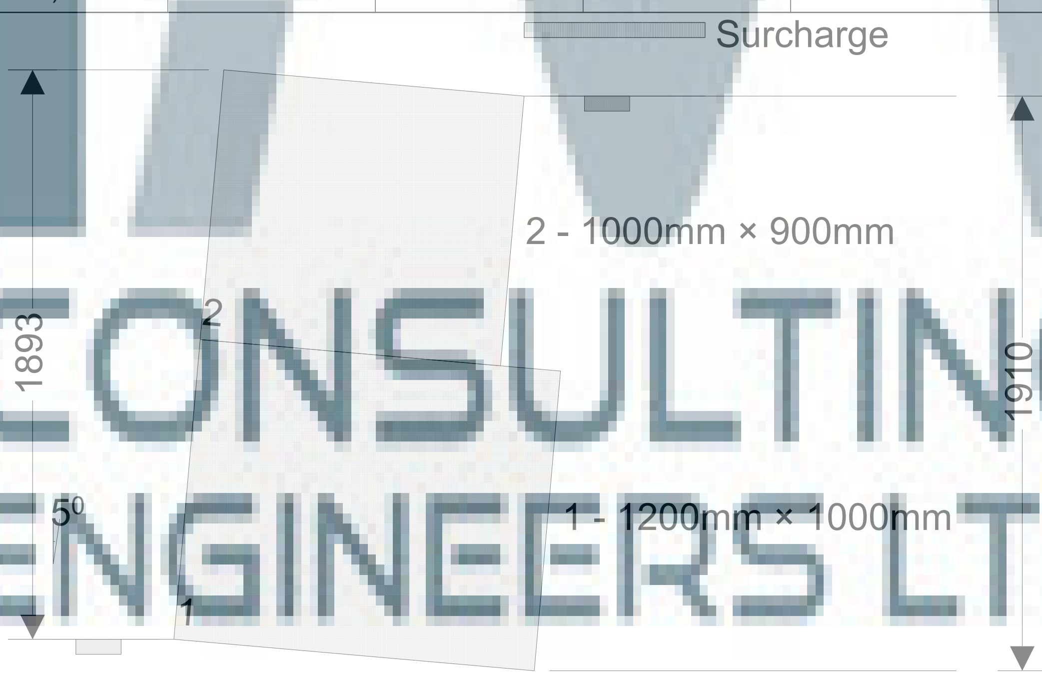
Design summary

Combination 1

Action	Resistance	Force	FoS	Allowable FoS	Status
Overturning, sliding and bearing at base level					
Overturning (kNm/m)	30.8	13.9	2.216	1.000	PASS
Sliding (kN/m)	30.5	17.5	1.748	1.000	PASS
Bearing (kN/m^2)	100.0	60.3	1.659	1.000	PASS
Eccentricity (mm)	Reaction acts within the middle third of base				PASS
Overturning and sliding between courses 1 and 2					
Overturning (kNm/m)	9.6	1.8	5.395	1.000	PASS
Sliding (kN/m)	12.2	4.5	2.727	1.000	PASS

Combination 2

Action	Resistance	Force	FoS	Allowable FoS	Status
Overturning, sliding and bearing at base level					
Overturning (kNm/m)	30.9	13.9	2.214	1.000	PASS
Sliding (kN/m)	24.4	17.1	1.426	1.000	PASS
Bearing (kN/m^2)	100.0	60.3	1.659	1.000	PASS
Eccentricity (mm)	Reaction acts within the middle third of base				PASS
Overturning and sliding between courses 1 and 2					
Overturning (kNm/m)	9.5	1.9	5.094	1.000	PASS
Sliding (kN/m)	9.8	4.7	2.081	1.000	PASS



CONSULTING ENGINEERS LTD	PROJECT: PROPOSED RETAINING WALL - THORNABY TS17 8QE				Job Ref.	
	STRUCTURAL CALCULATIONS: GABION RETAINING WALL (RW-1) DESIGN CHECK				Sheet no./rev. 2	
	Calc. by	Date 02/17/2019	Chk'd by	Date	App'd by	Date

Wall geometry

Width of gabion 1	$w_1 = \mathbf{1200}$ mm
Height of gabion 1	$h_1 = \mathbf{1000}$ mm
Width of gabion 2	$w_2 = \mathbf{1000}$ mm
Height of gabion 2	$h_2 = \mathbf{900}$ mm
Step to front face between courses 1 and 2	$s_2 = \mathbf{0}$ mm
Wall inclination	$\varepsilon = \mathbf{5}$ deg

Gabion properties

Unit weight of fill	$\gamma_d = \mathbf{18.0}$ kN/m^3
Friction between gabions	$\delta_{bg.k} = \mathbf{35.0}$ deg

Loading

Variable surcharge	$p_{o,Q} = \mathbf{10}$ kN/m^2

Soil properties

Slope of retained soil	$\beta = \mathbf{0.0}$ deg
Characteristic peak shearing resistance angle	$\phi'_{pk.k} = \mathbf{30.0}$ deg
Characteristic saturated density of retained soil	$\gamma_{sr} = \mathbf{19.5}$ kN/m^3
Coefficient for wall friction	$k_{membrane} = \mathbf{0.75}$
Wall friction angle	$\delta_{r.k} = \mathbf{22.5}$ deg
Characteristic base friction angle	$\delta_{bb.k} = \mathbf{34.0}$ deg
Bearing capacity of founding soil	$q = \mathbf{100}$ kN/m^2

Wall geometry

Horizontal distance to centre of gravity gabion 1	$x_{g1} = w_1 / 2 = \mathbf{600}$ mm
Vertical distance to centre of gravity gabion 1	$y_{g1} = h_1 / 2 = \mathbf{500}$ mm
Weight of gabion 1	$W_{g1} = \gamma_d \times w_1 \times h_1 = \mathbf{21.6}$ kN/m
Horizontal distance to centre of gravity gabion 2	$x_{g2} = w_2 / 2 + s_2 = \mathbf{500}$ mm
Vertical distance to centre of gravity gabion 2	$y_{g2} = h_2 / 2 + h_1 = \mathbf{1450}$ mm
Weight of gabion 2	$W_{g2} = \gamma_d \times w_2 \times h_2 = \mathbf{16.2}$ kN/m
Weight of entire gabion	$W_g = W_{g1} + W_{g2} = \mathbf{37.8}$ kN/m
Horiz distance to centre of gravity entire gabion	$x_g = ((W_{g1} \times x_{g1}) + (W_{g2} \times x_{g2})) / W_g = \mathbf{557}$ mm
Vert distance to centre of gravity entire gabion	$y_g = ((W_{g1} \times y_{g1}) + (W_{g2} \times y_{g2})) / W_g = \mathbf{907}$ mm
Correcting for wall inclination horiz dist	$X_g = x_g \times \cos(\varepsilon) + y_g \times \sin(\varepsilon) = \mathbf{634}$ mm
Vertical change in height due to wall inclination	$H_f = y_{g2} + h_2/2 - ((y_{g2} + h_2/2) \times \cos(\varepsilon) - (x_{g2} + w_2/2) \times \sin(\varepsilon)) = \mathbf{94}$ mm

Design dimensions

Effective angle of rear plane of wall	$\alpha = 90\text{deg} - \text{Atan}((w_1 - (x_{g2} + (w_2 / 2))) / (y_{g2} + h_2 / 2)) + \varepsilon = \mathbf{89.0}$ deg
Effective face angle	$\theta = 90\text{deg} - \varepsilon = \mathbf{85.0}$ deg
Effective height of wall	$H = (y_{g2} + h_2 / 2) + (w_1 \times \sin(\varepsilon)) - H_f = \mathbf{1910}$ mm
Height of wall from toe to front edge of top gabion	$H_{incl} = ((y_{g2} + h_2 / 2) \times \cos(\varepsilon) - (x_{g2} - (w_2 / 2)) \times \sin(\varepsilon)) = \mathbf{1893}$mm
Active pressure using Coulomb theory	$K_a = \sin(\alpha + \phi'_{r.k})^2 / (\sin(\alpha)^2 \times \sin(\alpha - \delta_{r.k}) \times (1 + \sqrt{}(\sin(\phi'_{r.k} + \delta_{r.k}) \times \sin(\phi'_{r.k} - \beta) / (\sin(\alpha - \delta_{r.k}) \times \sin(\alpha + \beta))))^2) = \mathbf{0.304}$
Active thrust due to soil	$P_{a,soil} = 0.5 \times K_a \times \gamma_{sr} \times H^2 = \mathbf{10.8}$ kN/m
Minimum surcharge (cl.4.6.3.2)	$p_{o,min} = \min(H / H_{ref}, 1) \times q_{d,min} = \mathbf{6.4}$ kN/m^2

Pressure at base

Horizontal forces

Retained soil $F_{soil\_h,q} = P_{a,soil} \times \cos(90 - \alpha + \delta_{r.k})$ = **9.9** kN/m

Height of soil thrust resolved vertically $d_{h,soil} = H / 3 - w_1 \times \sin(\varepsilon)$ = **532** mm

Surcharge $F_{surch\_h,q} = \max(p_{o,Q}, p_{o,min}) \times K_a \times H \times \cos(90 - \alpha + \delta_{r.k})$ = **5.3** kN/m

Height of surcharge thrust resolved vertically $d_{h,surch} = H / 2 - w_1 \times \sin(\varepsilon)$ = **851** mm

Vertical forces

Gabion weight $F_{gabion\_v,q} = W_g$ = **37.8** kN/m

Retained soil $F_{soil\_v,q} = P_{a,soil} \times \sin(90 - \alpha + \delta_{r.k})$ = **4.3** kN/m

Horizontal dist to where soil thrust acts $b_{v,soil} = w_1 \times \cos(\varepsilon) - (H / 3) / \tan(\alpha)$ = **1184** mm

Surcharge $F_{surch\_v,q} = \max(p_{o,Q}, p_{o,min}) \times K_a \times H \times \sin(90 - \alpha + \delta_{r.k})$ = **2.3** kN/m

Horizontal dist to where surcharge thrust acts $b_{v,surch} = w_1 \times \cos(\varepsilon) - (H / 2) / \tan(\alpha)$ = **1179** mm

Total horizontal unfactored force $T_q = F_{soil\_h,q} + F_{surch\_h,q}$ = **15.2** kN/m

Total vertical unfactored force $N_q = F_{gabion\_v,q} + F_{soil\_v,q} + F_{surch\_v,q}$ = **44.4** kN/m

Force normal to base $N_s = N_q \times \cos(\varepsilon) + T_q \times \sin(\varepsilon)$ = **45.6** kN/m

Total unfactored overturning force $M_{o,q} = F_{soil\_h,q} \times d_{h,soil} + F_{surch\_h,q} \times d_{h,surch}$ = **9.8** kNm/m

Total unfactored restoring force $M_{R,q} = F_{gabion\_v,q} \times X_g + F_{soil\_v,q} \times b_{v,soil} + F_{surch\_v,q} \times b_{v,surch}$ = **31.8** kNm/m

Eccentricity $e = w_1 / 2 - (M_{R,q} - M_{o,q}) / N_s$ = **117** mm

Reaction acts within middle third of base

Pressure at toe $\sigma_{toe} = N_s / w_1 \times (1 + (6 \times e / w_1))$ = **60.3** kN/m^2

Pressure at heel $\sigma_{heel} = N_s / w_1 \times (1 - (6 \times e / w_1))$ = **15.7** kN/m^2

Factor of safety $FoS_Q = q / \max(\sigma_{toe}, \sigma_{heel})$ = **1.659**

Allowable factor of safety FoS_{Q_allow} = **1.000**

PASS - Design FoS for allowable bearing pressure exceeds min allowable pressure to base

Design approach 1

Partial factors on actions - Section A.3.1 - Combination 1

Permanent unfavourable action γ_G = **1.35**

Permanent favourable action $\gamma_{G,f}$ = **1.00**

Variable unfavourable action γ_Q = **1.50**

Variable favourable action $\gamma_{Q,f}$ = **0.00**

Partial factors for soil parameters - Section A.3.2 - Combination 1

Angle of shearing resistance $\gamma_{\phi'}$ = **1.00**

Weight density γ_γ = **1.00**

Design soil properties

Design effective shearing resistance angle $\phi'_{r.d} = \text{Atan}(\tan(\phi'_{pk.k}) / \gamma_{\phi'})$ = **30.0** deg

Design saturated density of retained soil $\gamma_{s.d} = \gamma_{sr} / \gamma_\gamma$ = **19.5** kN/m^3

Design wall friction angle (cl.5.4.2.1) $\delta_{r.d} = \min(\text{atan}(\tan(\delta_{r.k}) / \gamma_{\phi'}), \phi'_{r.d} \times k_{membrane})$ = **22.5** deg

Design base friction angle $\delta_{bb.d} = \text{Atan}(\tan(\delta_{bb.k}) / \gamma_{\phi'})$ = **34.0** deg

Design friction between gabions $\delta_{bg.d} = \text{Atan}(\tan(\delta_{bg.k}) / \gamma_{\phi'})$ = **35.0** deg

Active pressure using Coulomb theory $K_a = \sin(\alpha + \phi'_{r.d})^2 / (\sin(\alpha)^2 \times \sin(\alpha - \delta_{r.d}) \times (1 + \sqrt{(\sin(\phi'_{r.d} + \delta_{r.d}) \times \sin(\phi'_{r.d} - \beta) / (\sin(\alpha - \delta_{r.d}) \times \sin(\alpha + \beta)))})^2)$ = **0.304**

Active thrust due to soil $P_{a,soil} = 0.5 \times K_a \times \gamma_{s.d} \times H^2 =$ **10.8** kN/m

Minimum surcharge (cl.4.6.3.2) $p_{o,min} = \min(H / H_{ref}, 1) \times q_{d,min} =$ **6.4** kN/m²

Horizontal forces

Retained soil $F_{soil\_h} = \gamma_G \times P_{a,soil} \times \cos(90 - \alpha + \delta_{r.d}) =$ **13.4** kN/m

Surcharge $F_{surch\_h} = \max(p_{o,Q} \times \gamma_Q, p_{o,min}) \times K_a \times H \times \cos(90 - \alpha + \delta_{r.d}) =$ **8.0** kN/m

Vertical forces

Gabion weight $F_{gabion\_v,f} = \gamma_{G,f} \times W_g =$ **37.8** kN/m

Retained soil $F_{soil\_v,f} = \gamma_{G,f} \times P_{a,soil} \times \sin(90 - \alpha + \delta_{r.d}) =$ **4.3** kN/m

Surcharge $F_{surch\_v,f} = \max(p_{o,Q} \times \gamma_{Q,f}, p_{o,min}) \times K_a \times H \times \sin(90 - \alpha + \delta_{r.d}) =$ **1.5** kN/m

Overturning stability - take moments about the toe

Overturning moment $M_o = F_{soil\_h} \times d_{h,soil} + F_{surch\_h} \times d_{h,surch} =$ **13.9** kNm/m

Restoring moment $M_R = F_{gabion\_v,f} \times X_g + F_{soil\_v,f} \times b_{v,soil} + F_{surch\_v,f} \times b_{v,surch} =$ **30.8** kNm/m

Factor of safety $FoS_M = M_R / M_o =$ **2.216**

Allowable factor of safety $FoS_{M\_allow} =$ **1.000**

PASS - Design FOS for overturning exceeds min allowable FOS for overturning

Sliding stability - ignore any passive pressure in front of the structure

Total horizontal force $T = F_{soil\_h} + F_{surch\_h} =$ **21.4** kN/m

Total vertical force $N = F_{gabion\_v,f} + F_{soil\_v,f} + F_{surch\_v,f} =$ **43.6** kN/m

Sliding force $F_f = T \times \cos(\varepsilon) - N \times \sin(\varepsilon) =$ **17.5** kN/m

Sliding resistance $F_R = (T \times \sin(\varepsilon) + N \times \cos(\varepsilon)) \times \tan(\delta_{bb.d}) =$ **30.5** kN/m

Factor of safety $FoS_S = F_R / F_f =$ **1.748**

Allowable factor of safety $FoS_{S\_allow} =$ **1.000**

PASS - Design FOS for sliding exceeds min allowable FOS for sliding

Check overturning and sliding between courses 1 and 2

Wall geometry

Horizontal distance to centre of gravity gabion 2 $x_{g2} = w_2 / 2 =$ **500** mm

Vertical distance to centre of gravity gabion 2 $y_{g2} = h_2 / 2 =$ **450** mm

Weight of gabion 2 $W_{g2} = \gamma_d \times w_2 \times h_2 =$ **16.2** kN/m

Weight of entire gabion $W_g = W_{g2} =$ **16.2** kN/m

Horiz distance to centre of gravity entire gabion $x_g = ((W_{g2} \times x_{g2})) / W_g =$ **500** mm

Vert distance to centre of gravity entire gabion $y_g = ((W_{g2} \times y_{g2})) / W_g =$ **450** mm

Correcting for wall inclination horiz dist $X_g = x_g \times \cos(\varepsilon) + y_g \times \sin(\varepsilon) =$ **537** mm

Vertical change in height due to wall inclination $H_f = y_{g2} + h_2/2 - ((y_{g2} + h_2/2) \times \cos(\varepsilon) - (x_{g2} + w_2/2) \times \sin(\varepsilon)) =$ **91** mm

Design dimensions

Effective angle of rear plane of wall $\alpha = 90 \text{ deg} + \varepsilon =$ **95.0** deg

Effective face angle $\theta = 90\text{deg} - \varepsilon =$ **85.0** deg

Effective height of wall $H = (y_{g2} + h_2 / 2) + (w_2 \times \sin(\varepsilon)) - H_f =$ **897** mm

Height of wall from toe to front edge of top gabion $H_{incl} = ((y_{g2} + h_2 / 2) \times \cos(\varepsilon) - (x_{g2} - (w_2 / 2)) \times \sin(\varepsilon)) =$ **897**mm

Active pressure using Coulomb theory $K_a = \sin(\alpha + \phi'_{r.d})^2 / (\sin(\alpha)^2 \times \sin(\alpha - \delta_{r.d}) \times (1 + \sqrt{(\sin(\phi'_{r.d} + \delta_{r.d}) \times \sin(\phi'_{r.d} - \beta)} / (\sin(\alpha - \delta_{r.d}) \times \sin(\alpha + \beta))))^2) =$ **0.262**

Active thrust due to soil $P_{a,soil} = 0.5 \times K_a \times \gamma_{s.d} \times H^2 =$ **2.1** kN/m

Minimum surcharge (cl.4.6.3.2) $p_{o,min} = \min(H / H_{ref}, 1) \times q_{d,min} = \mathbf{3.0}$ kN/m^2

Horizontal forces

Retained soil $F_{soil\_h} = \gamma_G \times P_{a,soil} \times \cos(90 - \alpha + \delta_{r.d}) = \mathbf{2.6}$ kN/m

Surcharge $F_{surch\_h} = \max(p_{o,Q} \times \gamma_Q, p_{o,min}) \times K_a \times H \times \cos(90 - \alpha + \delta_{r.d}) = \mathbf{3.4}$ kN/m

Vertical forces

Gabion weight $F_{gabion\_v,f} = \gamma_{G,f} \times W_g = \mathbf{16.2}$ kN/m

Retained soil $F_{soil\_v,f} = \gamma_{G,f} \times P_{a,soil} \times \sin(90 - \alpha + \delta_{r.d}) = \mathbf{0.6}$ kN/m

Surcharge $F_{surch\_v,f} = \max(p_{o,Q} \times \gamma_{Q,f}, p_{o,min}) \times K_a \times H \times \sin(90 - \alpha + \delta_{r.d}) = \mathbf{0.2}$ kN/m

Overturning stability - take moments about the toe

Overturning moment $M_o = F_{soil\_h} \times d_{h,soil} + F_{surch\_h} \times d_{h,surch} = \mathbf{1.8}$ kNm/m

Restoring moment $M_R = F_{gabion\_v,f} \times X_g + F_{soil\_v,f} \times b_{v,soil} + F_{surch\_v,f} \times b_{v,surch} = \mathbf{9.6}$ kNm/m

Factor of safety $FoS_M = M_R / M_o = \mathbf{5.395}$

Allowable factor of safety $FoS_{M\_allow} = \mathbf{1.000}$

PASS - Design FOS for overturning exceeds min allowable FOS for overturning

Sliding stability - ignore any passive pressure in front of the structure

Total horizontal force $T = F_{soil\_h} + F_{surch\_h} = \mathbf{6.0}$ kN/m

Total vertical force $N = F_{gabion\_v,f} + F_{soil\_v,f} + F_{surch\_v,f} = \mathbf{17.0}$ kN/m

Sliding force $F_f = T \times \cos(\varepsilon) - N \times \sin(\varepsilon) = \mathbf{4.5}$ kN/m

Sliding resistance $F_R = (T \times \sin(\varepsilon) + N \times \cos(\varepsilon)) \times \tan(\delta_{bg.d}) = \mathbf{12.2}$ kN/m

Factor of safety $FoS_S = F_R / F_f = \mathbf{2.727}$

Allowable factor of safety $FoS_{S\_allow} = \mathbf{1.000}$

PASS - Design FOS for sliding exceeds min allowable FOS for sliding

Design approach 1

Partial factors on actions - Section A.3.1 - Combination 2

Permanent unfavourable action $\gamma_G = \mathbf{1.00}$

Permanent favourable action $\gamma_{G,f} = \mathbf{1.00}$

Variable unfavourable action $\gamma_Q = \mathbf{1.30}$

Variable favourable action $\gamma_{Q,f} = \mathbf{0.00}$

Partial factors for soil parameters - Section A.3.2 - Combination 2

Angle of shearing resistance $\gamma_{\phi'} = \mathbf{1.25}$

Weight density $\gamma_\gamma = \mathbf{1.00}$

Design soil properties

Design effective shearing resistance angle $\phi'_{r.d} = \mathrm{Atan}(\tan(\phi'_{pk.k}) / \gamma_{\phi'}) = \mathbf{24.8}$ deg

Design saturated density of retained soil $\gamma_{s.d} = \gamma_{sr} / \gamma_\gamma = \mathbf{19.5}$ kN/m^3

Design wall friction angle (cl.5.4.2.1) $\delta_{r.d} = \min(\mathrm{atan}(\tan(\delta_{r.k}) / \gamma_{\phi'}), \phi'_{r.d} \times k_{membrane}) = \mathbf{18.3}$ deg

Design base friction angle $\delta_{bb.d} = \mathrm{Atan}(\tan(\delta_{bb.k}) / \gamma_{\phi'}) = \mathbf{28.4}$ deg

Design friction between gabions $\delta_{bg.d} = \mathrm{Atan}(\tan(\delta_{bg.k}) / \gamma_{\phi'}) = \mathbf{29.3}$ deg

Wall geometry

Horizontal distance to centre of gravity gabion 1 $x_{g1} = w_1 / 2 = \mathbf{600}$ mm

Vertical distance to centre of gravity gabion 1 $y_{g1} = h_1 / 2 = \mathbf{500}$ mm

Weight of gabion 1 $W_{g1} = \gamma_d \times w_1 \times h_1 = \mathbf{21.6}$ kN/m

Horizontal distance to centre of gravity gabion 2 — $x_{g2} = w_2 / 2 + s_2 =$ **500** mm

Vertical distance to centre of gravity gabion 2 — $y_{g2} = h_2 / 2 + h_1 =$ **1450** mm

Weight of gabion 2 — $W_{g2} = \gamma_d \times w_2 \times h_2 =$ **16.2** kN/m

Weight of entire gabion — $W_g = W_{g1} + W_{g2} =$ **37.8** kN/m

Horiz distance to centre of gravity entire gabion — $x_g = ((W_{g1} \times x_{g1}) + (W_{g2} \times x_{g2})) / W_g =$ **557** mm

Vert distance to centre of gravity entire gabion — $y_g = ((W_{g1} \times y_{g1}) + (W_{g2} \times y_{g2})) / W_g =$ **907** mm

Correcting for wall inclination horiz dist — $X_g = x_g \times \cos(\varepsilon) + y_g \times \sin(\varepsilon) =$ **634** mm

Vertical change in height due to wall inclination — $H_f = y_{g2} + h_2/2 - ((y_{g2} + h_2/2) \times \cos(\varepsilon) - (x_{g2} + w_2/2) \times \sin(\varepsilon)) =$ **94** mm

Design dimensions

Effective angle of rear plane of wall — $\alpha = 90\text{deg} - \text{Atan}((w_1 - (x_{g2} + (w_2 / 2))) / (y_{g2} + h_2 / 2)) + \varepsilon =$ **89.0** deg

Effective face angle — $\theta = 90\text{deg} - \varepsilon =$ **85.0** deg

Effective height of wall — $H = (y_{g2} + h_2 / 2) + (w_1 \times \sin(\varepsilon)) - H_f =$ **1910** mm

Height of wall from toe to front edge of top gabion — $H_{incl} = ((y_{g2} + h_2 / 2) \times \cos(\varepsilon) - (x_{g2} - (w_2 / 2)) \times \sin(\varepsilon)) =$ **1893**mm

Active pressure using Coulomb theory — $K_a = \sin(\alpha + \phi'_{r.d})^2 / (\sin(\alpha)^2 \times \sin(\alpha - \delta_{r.d}) \times (1 + \sqrt{}(\sin(\phi'_{r.d} + \delta_{r.d}) \times \sin(\phi'_{r.d} - \beta) / (\sin(\alpha - \delta_{r.d}) \times \sin(\alpha + \beta))))^2) =$ **0.369**

Active thrust due to soil — $P_{a,soil} = 0.5 \times K_a \times \gamma_{s.d} \times H^2 =$ **13.1** kN/m

Minimum surcharge (cl.4.6.3.2) — $p_{o,min} = \min(H / H_{ref}, 1) \times q_{d,min} =$ **6.4** kN/m^2

Horizontal forces

Retained soil — $F_{soil\_h} = \gamma_G \times P_{a,soil} \times \cos(90 - \alpha + \delta_{r.d}) =$ **12.4** kN/m

Surcharge — $F_{surch\_h} = \max(p_{o,Q} \times \gamma_Q, p_{o,min}) \times K_a \times H \times \cos(90 - \alpha + \delta_{r.d}) =$ **8.6** kN/m

Vertical forces

Gabion weight — $F_{gabion\_v,f} = \gamma_{G,f} \times W_g =$ **37.8** kN/m

Retained soil — $F_{soil\_v,f} = \gamma_{G,f} \times P_{a,soil} \times \sin(90 - \alpha + \delta_{r.d}) =$ **4.3** kN/m

Surcharge — $F_{surch\_v,f} = \max(p_{o,Q} \times \gamma_{Q,f}, p_{o,min}) \times K_a \times H \times \sin(90 - \alpha + \delta_{r.d}) =$ **1.5** kN/m

Overturning stability - take moments about the toe

Overturning moment — $M_o = F_{soil\_h} \times d_{h,soil} + F_{surch\_h} \times d_{h,surch} =$ **13.9** kNm/m

Restoring moment — $M_R = F_{gabion\_v,f} \times X_g + F_{soil\_v,f} \times b_{v,soil} + F_{surch\_v,f} \times b_{v,surch} =$ **30.9** kNm/m

Factor of safety — $FoS_M = M_R / M_o =$ **2.214**

Allowable factor of safety — $FoS_{M\_allow} =$ **1.000**

PASS - Design FOS for overturning exceeds min allowable FOS for overturning

Sliding stability - ignore any passive pressure in front of the structure

Total horizontal force — $T = F_{soil\_h} + F_{surch\_h} =$ **21.0** kN/m

Total vertical force — $N = F_{gabion\_v,f} + F_{soil\_v,f} + F_{surch\_v,f} =$ **43.6** kN/m

Sliding force — $F_f = T \times \cos(\varepsilon) - N \times \sin(\varepsilon) =$ **17.1** kN/m

Sliding resistance — $F_R = (T \times \sin(\varepsilon) + N \times \cos(\varepsilon)) \times \tan(\delta_{bb.d}) =$ **24.4** kN/m

Factor of safety — $FoS_S = F_R / F_f =$ **1.426**

Allowable factor of safety — $FoS_{S\_allow} =$ **1.000**

PASS - Design FOS for sliding exceeds min allowable FOS for sliding

Check overturning and sliding between courses 1 and 2

Wall geometry

Horizontal distance to centre of gravity gabion 2 — $x_{g2} = w_2 / 2 =$ **500** mm

Vertical distance to centre of gravity gabion 2 — $y_{g2} = h_2 / 2 =$ **450** mm

Weight of gabion 2 — $W_{g2} = \gamma_d \times w_2 \times h_2 =$ **16.2** kN/m

Weight of entire gabion — $W_g = W_{g2} =$ **16.2** kN/m

Horiz distance to centre of gravity entire gabion — $x_g = ((W_{g2} \times x_{g2})) / W_g =$ **500** mm

Vert distance to centre of gravity entire gabion — $y_g = ((W_{g2} \times y_{g2})) / W_g =$ **450** mm

Correcting for wall inclination horiz dist — $X_g = x_g \times \cos(\varepsilon) + y_g \times \sin(\varepsilon) =$ **537** mm

Vertical change in height due to wall inclination — $H_f = y_{g2} + h_2/2 - ((y_{g2} + h_2/2) \times \cos(\varepsilon) - (x_{g2} + w_2/2) \times \sin(\varepsilon)) =$ **91** mm

Design dimensions

Effective angle of rear plane of wall — $\alpha = 90 \text{ deg} + \varepsilon =$ **95.0** deg

Effective face angle — $\theta = 90\text{deg} - \varepsilon =$ **85.0** deg

Effective height of wall — $H = (y_{g2} + h_2 / 2) + (w_2 \times \sin(\varepsilon)) - H_f =$ **897** mm

Height of wall from toe to front edge of top gabion — $H_{incl} = ((y_{g2} + h_2 / 2) \times \cos(\varepsilon) - (x_{g2} - (w_2 / 2)) \times \sin(\varepsilon)) =$ **897**mm

Active pressure using Coulomb theory — $K_a = \sin(\alpha + \phi'_{r.d})^2 / (\sin(\alpha)^2 \times \sin(\alpha - \delta_{r.d}) \times (1 + \sqrt{(\sin(\phi'_{r.d} + \delta_{r.d}) \times \sin(\phi'_{r.d} - \beta)} / (\sin(\alpha - \delta_{r.d}) \times \sin(\alpha + \beta))))^2) =$ **0.327**

Active thrust due to soil — $P_{a,soil} = 0.5 \times K_a \times \gamma_{s.d} \times H^2 =$ **2.6** kN/m

Minimum surcharge (cl.4.6.3.2) — $p_{o,min} = \min(H / H_{ref}, 1) \times q_{d,min} =$ **3.0** kN/m²

Horizontal forces

Retained soil — $F_{soil\_h} = \gamma_G \times P_{a,soil} \times \cos(90 - \alpha + \delta_{r.d}) =$ **2.5** kN/m

Surcharge — $F_{surch\_h} = \max(p_{o,Q} \times \gamma_Q, p_{o,min}) \times K_a \times H \times \cos(90 - \alpha + \delta_{r.d}) =$ **3.7** kN/m

Vertical forces

Gabion weight — $F_{gabion\_v,f} = \gamma_{G,f} \times W_g =$ **16.2** kN/m

Retained soil — $F_{soil\_v,f} = \gamma_{G,f} \times P_{a,soil} \times \sin(90 - \alpha + \delta_{r.d}) =$ **0.6** kN/m

Surcharge — $F_{surch\_v,f} = \max(p_{o,Q} \times \gamma_{Q,f}, p_{o,min}) \times K_a \times H \times \sin(90 - \alpha + \delta_{r.d}) =$ **0.2** kN/m

Overturning stability - take moments about the toe

Overturning moment — $M_o = F_{soil\_h} \times d_{h,soil} + F_{surch\_h} \times d_{h,surch} =$ **1.9** kNm/m

Restoring moment — $M_R = F_{gabion\_v,f} \times X_g + F_{soil\_v,f} \times b_{v,soil} + F_{surch\_v,f} \times b_{v,surch} =$ **9.5** kNm/m

Factor of safety — $FoS_M = M_R / M_o =$ **5.094**

Allowable factor of safety — $FoS_{M\_allow} =$ **1.000**

PASS - Design FOS for overturning exceeds min allowable FOS for overturning

Sliding stability - ignore any passive pressure in front of the structure

Total horizontal force — $T = F_{soil\_h} + F_{surch\_h} =$ **6.2** kN/m

Total vertical force — $N = F_{gabion\_v,f} + F_{soil\_v,f} + F_{surch\_v,f} =$ **17.0** kN/m

Sliding force — $F_f = T \times \cos(\varepsilon) - N \times \sin(\varepsilon) =$ **4.7** kN/m

Sliding resistance — $F_R = (T \times \sin(\varepsilon) + N \times \cos(\varepsilon)) \times \tan(\delta_{bg.d}) =$ **9.8** kN/m

Factor of safety — $FoS_S = F_R / F_f =$ **2.081**

Allowable factor of safety — $FoS_{S\_allow} =$ **1.000**

PASS - Design FOS for sliding exceeds min allowable FOS for sliding

PROJECT: PROPOSED RETAINING WALL - THORNABY TS17 8QE				Job Ref.	
STRUCTURAL CALCULATIONS: GABION RETAINING WALL (RW-2) DESIGN CHECK				Sheet no./rev. 1	
Calc. by	Date 02/17/2019	Chk'd by	Date	App'd by	Date

GABION RETAINING WALL ANLYSIS & DESIGN

In accordance with BS8002:2015 - Code of Practice for Earth Retaining Structures and the UK National Annex

Tedds calculation version 2.0.01

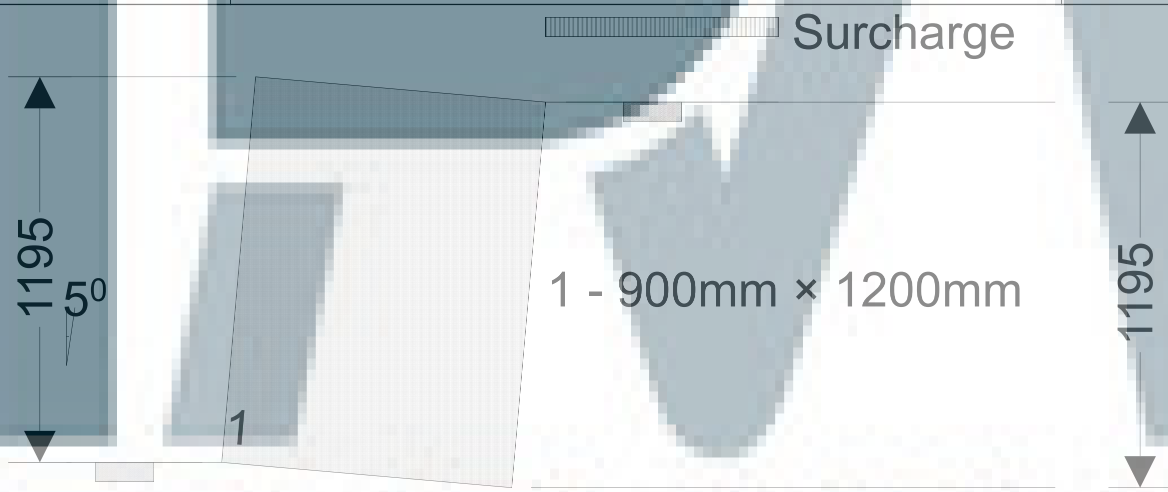
Design summary

Combination 1

Action	Resistance	Force	FoS	Allowable FoS	Status
Overturning, sliding and bearing at base level					
Overturning (kNm/m)	11.1	3.8	2.904	1.000	PASS
Sliding (kN/m)	14.6	7.3	1.996	1.000	PASS
Bearing (kN/m^2)	100.0	31.0	3.221	1.000	PASS
Eccentricity (mm)	Reaction acts within the middle third of base				PASS

Combination 2

Action	Resistance	Force	FoS	Allowable FoS	Status
Overturning, sliding and bearing at base level					
Overturning (kNm/m)	11.1	4.0	2.770	1.000	PASS
Sliding (kN/m)	11.6	7.5	1.547	1.000	PASS
Bearing (kN/m^2)	100.0	31.0	3.221	1.000	PASS
Eccentricity (mm)	Reaction acts within the middle third of base				PASS



Wall geometry

Width of gabion 1 w_1 = **900** mm

Height of gabion 1 h_1 = **1200** mm

Wall inclination ε = **5** deg

Gabion properties

Unit weight of fill γ_d = **18.0** kN/m^3

Friction between gabions $\delta_{bg.k}$ = **35.0** deg

Loading

Variable surcharge $p_{o,Q}$ = **10** kN/m^2

Soil properties

Slope of retained soil: β = **0.0** deg

Characteristic peak shearing resistance angle: $\phi'_{pk.k}$ = **30.0** deg

Characteristic saturated density of retained soil: γ_{sr} = **19.5** kN/m^3

Coefficient for wall friction: $k_{membrane}$ = **0.75**

Wall friction angle: $\delta_{r.k}$ = **22.5** deg

Characteristic base friction angle: $\delta_{bb.k}$ = **34.0** deg

Bearing capacity of founding soil: q = **100** kN/m^2

Wall geometry

Horizontal distance to centre of gravity gabion 1: $x_{g1} = w_1 / 2$ = **450** mm

Vertical distance to centre of gravity gabion 1: $y_{g1} = h_1 / 2$ = **600** mm

Weight of gabion 1: $W_{g1} = \gamma_d \times w_1 \times h_1$ = **19.4** kN/m

Weight of entire gabion: $W_g = W_{g1}$ = **19.4** kN/m

Horiz distance to centre of gravity entire gabion: $x_g = ((W_{g1} \times x_{g1})) / W_g$ = **450** mm

Vert distance to centre of gravity entire gabion: $y_g = ((W_{g1} \times y_{g1})) / W_g$ = **600** mm

Correcting for wall inclination horiz dist: $X_g = x_g \times \cos(\varepsilon) + y_g \times \sin(\varepsilon)$ = **501** mm

Vertical change in height due to wall inclination: $H_f = y_{g1} + h_1/2 - ((y_{g1} + h_1/2) \times \cos(\varepsilon) - (x_{g1} + w_1/2) \times \sin(\varepsilon))$ = **83** mm

Design dimensions

Effective angle of rear plane of wall: $\alpha = 90 \text{ deg} + \varepsilon$ = **95.0** deg

Effective face angle: $\theta = 90\text{deg} - \varepsilon$ = **85.0** deg

Effective height of wall: $H = (y_{g1} + h_1 / 2) + (w_1 \times \sin(\varepsilon)) - H_f$ = **1195** mm

Height of wall from toe to front edge of top gabion: $H_{incl} = ((y_{g1} + h_1 / 2) \times \cos(\varepsilon) - (x_{g1} - (w_1 / 2)) \times \sin(\varepsilon))$ = **1195**mm

Active pressure using Coulomb theory: $K_a = \sin(\alpha + \phi'_{r.k})^2 / (\sin(\alpha)^2 \times \sin(\alpha - \delta_{r.k}) \times (1 + \sqrt{(\sin(\phi'_{r.k} + \delta_{r.k}) \times \sin(\phi'_{r.k} - \beta)} / (\sin(\alpha - \delta_{r.k}) \times \sin(\alpha + \beta))))^2)$ = **0.262**

Active thrust due to soil: $P_{a,soil} = 0.5 \times K_a \times \gamma_{sr} \times H^2$ = **3.6** kN/m

Minimum surcharge (cl.4.6.3.2): $p_{o,min} = \min(H / H_{ref}, 1) \times q_{d,min}$ = **4.0** kN/m^2

Pressure at base

Horizontal forces

Retained soil: $F_{soil\_h,q} = P_{a,soil} \times \cos(90 - \alpha + \delta_{r.k})$ = **3.5** kN/m

Height of soil thrust resolved vertically: $d_{h,soil} = H / 3 - w_1 \times \sin(\varepsilon)$ = **320** mm

Surcharge: $F_{surch\_h,q} = \max(p_{o,Q}, p_{o,min}) \times K_a \times H \times \cos(90 - \alpha + \delta_{r.k})$ = **3.0** kN/m

Height of surcharge thrust resolved vertically: $d_{h,surch} = H / 2 - w_1 \times \sin(\varepsilon)$ = **519** mm

Vertical forces

Gabion weight: $F_{gabion\_v,q} = W_g$ = **19.4** kN/m

Retained soil: $F_{soil\_v,q} = P_{a,soil} \times \sin(90 - \alpha + \delta_{r.k})$ = **1.1** kN/m

Horizontal dist to where soil thrust acts: $b_{v,soil} = w_1 \times \cos(\varepsilon) - (H / 3) / \tan(\alpha)$ = **931** mm

Surcharge: $F_{surch\_v,q} = \max(p_{o,Q}, p_{o,min}) \times K_a \times H \times \sin(90 - \alpha + \delta_{r.k})$ = **0.9** kN/m

Horizontal dist to where surcharge thrust acts: $b_{v,surch} = w_1 \times \cos(\varepsilon) - (H / 2) / \tan(\alpha)$ = **949** mm

Total horizontal unfactored force: $T_q = F_{soil\_h,q} + F_{surch\_h,q}$ = **6.5** kN/m

Total vertical unfactored force: $N_q = F_{gabion\_v,q} + F_{soil\_v,q} + F_{surch\_v,q}$ = **21.5** kN/m

Force normal to base: $N_s = N_q \times \cos(\varepsilon) + T_q \times \sin(\varepsilon)$ = **22.0** kN/m

Total unfactored overturning force $M_{o,q} = F_{soil\_h,q} \times d_{h,soil} + F_{surch\_h,q} \times d_{h,surch}$ = **2.7** kNm/m

Total unfactored restoring force $M_{R,q} = F_{gabion\_v,q} \times X_g + F_{soil\_v,q} \times b_{v,soil} + F_{surch\_v,q} \times b_{v,surch}$ = **11.6** kNm/m

Eccentricity $e = w_1 / 2 - (M_{R,q} - M_{o,q}) / N_s$ = **41** mm

Reaction acts within middle third of base

Pressure at toe $\sigma_{toe} = N_s / w_1 \times (1 + (6 \times e / w_1))$ = **31.0** kN/m^2

Pressure at heel $\sigma_{heel} = N_s / w_1 \times (1 - (6 \times e / w_1))$ = **17.7** kN/m^2

Factor of safety $FoS_Q = q / \max(\sigma_{toe}, \sigma_{heel})$ = **3.221**

Allowable factor of safety FoS_{Q_allow} = **1.000**

PASS - Design FoS for allowable bearing pressure exceeds min allowable pressure to base

Design approach 1

Partial factors on actions - Section A.3.1 - Combination 1

Permanent unfavourable action γ_G = **1.35**

Permanent favourable action $\gamma_{G,f}$ = **1.00**

Variable unfavourable action γ_Q = **1.50**

Variable favourable action $\gamma_{Q,f}$ = **0.00**

Partial factors for soil parameters - Section A.3.2 - Combination 1

Angle of shearing resistance $\gamma_{\phi'}$ = **1.00**

Weight density γ_γ = **1.00**

Design soil properties

Design effective shearing resistance angle $\phi'_{r.d} = \mathrm{Atan}(\tan(\phi'_{pk.k}) / \gamma_{\phi'})$ = **30.0** deg

Design saturated density of retained soil $\gamma_{s.d} = \gamma_{sr} / \gamma_\gamma$ = **19.5** kN/m^3

Design wall friction angle (cl.5.4.2.1) $\delta_{r.d} = \min(\mathrm{atan}(\tan(\delta_{r.k}) / \gamma_{\phi'}), \phi'_{r.d} \times k_{membrane})$ = **22.5** deg

Design base friction angle $\delta_{bb.d} = \mathrm{Atan}(\tan(\delta_{bb.k}) / \gamma_{\phi'})$ = **34.0** deg

Design friction between gabions $\delta_{bg.d} = \mathrm{Atan}(\tan(\delta_{bg.k}) / \gamma_{\phi'})$ = **35.0** deg

Active pressure using Coulomb theory $K_a = \sin(\alpha + \phi'_{r.d})^2 / (\sin(\alpha)^2 \times \sin(\alpha - \delta_{r.d}) \times (1 + \sqrt{(\sin(\phi'_{r.d} + \delta_{r.d}) \times \sin(\phi'_{r.d} - \beta)} / (\sin(\alpha - \delta_{r.d}) \times \sin(\alpha + \beta))))^2)$ = **0.262**

Active thrust due to soil $P_{a,soil} = 0.5 \times K_a \times \gamma_{s.d} \times H^2$ = **3.6** kN/m

Minimum surcharge (cl.4.6.3.2) $p_{o,min} = \min(H / H_{ref}, 1) \times q_{d,min}$ = **4.0** kN/m^2

Horizontal forces

Retained soil $F_{soil\_h} = \gamma_G \times P_{a,soil} \times \cos(90 - \alpha + \delta_{r.d})$ = **4.7** kN/m

Surcharge $F_{surch\_h} = \max(p_{o,Q} \times \gamma_Q, p_{o,min}) \times K_a \times H \times \cos(90 - \alpha + \delta_{r.d})$ = **4.5** kN/m

Vertical forces

Gabion weight $F_{gabion\_v,f} = \gamma_{G,f} \times W_g$ = **19.4** kN/m

Retained soil $F_{soil\_v,f} = \gamma_{G,f} \times P_{a,soil} \times \sin(90 - \alpha + \delta_{r.d})$ = **1.1** kN/m

Surcharge $F_{surch\_v,f} = \max(p_{o,Q} \times \gamma_{Q,f}, p_{o,min}) \times K_a \times H \times \sin(90 - \alpha + \delta_{r.d})$ = **0.4** kN/m

Overturning stability - take moments about the toe

Overturning moment $M_o = F_{soil\_h} \times d_{h,soil} + F_{surch\_h} \times d_{h,surch}$ = **3.8** kNm/m

Restoring moment $M_R = F_{gabion\_v,f} \times X_g + F_{soil\_v,f} \times b_{v,soil} + F_{surch\_v,f} \times b_{v,surch}$ = **11.1** kNm/m

Factor of safety $FoS_M = M_R / M_o$ = **2.904**

Allowable factor of safety FoS_{M_allow} = **1.000**

PASS - Design FOS for overturning exceeds min allowable FOS for overturning

Sliding stability - ignore any passive pressure in front of the structure

Total horizontal force: $T = F_{soil\_h} + F_{surch\_h} = \mathbf{9.2}$ kN/m

Total vertical force: $N = F_{gabion\_v,f} + F_{soil\_v,f} + F_{surch\_v,f} = \mathbf{20.9}$ kN/m

Sliding force: $F_f = T \times \cos(\varepsilon) - N \times \sin(\varepsilon) = \mathbf{7.3}$ kN/m

Sliding resistance: $F_R = (T \times \sin(\varepsilon) + N \times \cos(\varepsilon)) \times \tan(\delta_{bb.d}) = \mathbf{14.6}$ kN/m

Factor of safety: $FoS_S = F_R / F_f = \mathbf{1.996}$

Allowable factor of safety: $FoS_{S\_allow} = \mathbf{1.000}$

PASS - Design FOS for sliding exceeds min allowable FOS for sliding

Design approach 1

Partial factors on actions - Section A.3.1 - Combination 2

Permanent unfavourable action: $\gamma_G = \mathbf{1.00}$

Permanent favourable action: $\gamma_{G,f} = \mathbf{1.00}$

Variable unfavourable action: $\gamma_Q = \mathbf{1.30}$

Variable favourable action: $\gamma_{Q,f} = \mathbf{0.00}$

Partial factors for soil parameters - Section A.3.2 - Combination 2

Angle of shearing resistance: $\gamma_{\phi'} = \mathbf{1.25}$

Weight density: $\gamma_\gamma = \mathbf{1.00}$

Design soil properties

Design effective shearing resistance angle: $\phi'_{r.d} = \text{Atan}(\tan(\phi'_{pk.k}) / \gamma_{\phi'}) = \mathbf{24.8}$ deg

Design saturated density of retained soil: $\gamma_{s.d} = \gamma_{sr} / \gamma_\gamma = \mathbf{19.5}$ kN/m^3

Design wall friction angle (cl.5.4.2.1): $\delta_{r.d} = \min(\text{atan}(\tan(\delta_{r.k}) / \gamma_{\phi'}), \phi'_{r.d} \times k_{membrane}) = \mathbf{18.3}$ deg

Design base friction angle: $\delta_{bb.d} = \text{Atan}(\tan(\delta_{bb.k}) / \gamma_{\phi'}) = \mathbf{28.4}$ deg

Design friction between gabions: $\delta_{bg.d} = \text{Atan}(\tan(\delta_{bg.k}) / \gamma_{\phi'}) = \mathbf{29.3}$ deg

Wall geometry

Horizontal distance to centre of gravity gabion 1: $x_{g1} = w_1 / 2 = \mathbf{450}$ mm

Vertical distance to centre of gravity gabion 1: $y_{g1} = h_1 / 2 = \mathbf{600}$ mm

Weight of gabion 1: $W_{g1} = \gamma_d \times w_1 \times h_1 = \mathbf{19.4}$ kN/m

Weight of entire gabion: $W_g = W_{g1} = \mathbf{19.4}$ kN/m

Horiz distance to centre of gravity entire gabion: $x_g = ((W_{g1} \times x_{g1})) / W_g = \mathbf{450}$ mm

Vert distance to centre of gravity entire gabion: $y_g = ((W_{g1} \times y_{g1})) / W_g = \mathbf{600}$ mm

Correcting for wall inclination horiz dist: $X_g = x_g \times \cos(\varepsilon) + y_g \times \sin(\varepsilon) = \mathbf{501}$ mm

Vertical change in height due to wall inclination: $H_f = y_{g1} + h_1/2 - ((y_{g1} + h_1/2) \times \cos(\varepsilon) - (x_{g1} + w_1/2) \times \sin(\varepsilon)) = \mathbf{83}$ mm

Design dimensions

Effective angle of rear plane of wall: $\alpha = 90\text{ deg} + \varepsilon = \mathbf{95.0}$ deg

Effective face angle: $\theta = 90\text{deg} - \varepsilon = \mathbf{85.0}$ deg

Effective height of wall: $H = (y_{g1} + h_1 / 2) + (w_1 \times \sin(\varepsilon)) - H_f = \mathbf{1195}$ mm

Height of wall from toe to front edge of top gabion: $H_{incl} = ((y_{g1} + h_1 / 2) \times \cos(\varepsilon) - (x_{g1} - (w_1 / 2)) \times \sin(\varepsilon)) = \mathbf{1195}$mm

Active pressure using Coulomb theory: $K_a = \sin(\alpha + \phi'_{r.d})^2 / (\sin(\alpha)^2 \times \sin(\alpha - \delta_{r.d}) \times (1 + \sqrt{(\sin(\phi'_{r.d} + \delta_{r.d}) \times \sin(\phi'_{r.d} - \beta)} / (\sin(\alpha - \delta_{r.d}) \times \sin(\alpha + \beta))))^2) = \mathbf{0.327}$

Active thrust due to soil: $P_{a,soil} = 0.5 \times K_a \times \gamma_{s.d} \times H^2 = \mathbf{4.6}$ kN/m

Minimum surcharge (cl.4.6.3.2): $p_{o,min} = \min(H / H_{ref}, 1) \times q_{d,min} = \mathbf{4.0}$ kN/m^2

Horizontal forces

Retained soil $F_{soil\_h} = \gamma_G \times P_{a,soil} \times \cos(90 - \alpha + \delta_{r.d})$ = **4.4** kN/m

Surcharge $F_{surch\_h} = \max(p_{o,Q} \times \gamma_Q,\ p_{o,min}) \times K_a \times H \times \cos(90 - \alpha + \delta_{r.d})$ = **4.9** kN/m

Vertical forces

Gabion weight $F_{gabion\_v,f} = \gamma_{G,f} \times W_g$ = **19.4** kN/m

Retained soil $F_{soil\_v,f} = \gamma_{G,f} \times P_{a,soil} \times \sin(90 - \alpha + \delta_{r.d})$ = **1.1** kN/m

Surcharge $F_{surch\_v,f} = \max(p_{o,Q} \times \gamma_{Q,f},\ p_{o,min}) \times K_a \times H \times \sin(90 - \alpha + \delta_{r.d})$ = **0.4** kN/m

Overturning stability - take moments about the toe

Overturning moment $M_o = F_{soil\_h} \times d_{h,soil} + F_{surch\_h} \times d_{h,surch}$ = **4.0** kNm/m

Restoring moment $M_R = F_{gabion\_v,f} \times X_g + F_{soil\_v,f} \times b_{v,soil} + F_{surch\_v,f} \times b_{v,surch}$ = **11.1** kNm/m

Factor of safety $FoS_M = M_R / M_o$ = **2.770**

Allowable factor of safety FoS_{M_allow} = **1.000**

PASS - Design FOS for overturning exceeds min allowable FOS for overturning

Sliding stability - ignore any passive pressure in front of the structure

Total horizontal force $T = F_{soil\_h} + F_{surch\_h}$ = **9.4** kN/m

Total vertical force $N = F_{gabion\_v,f} + F_{soil\_v,f} + F_{surch\_v,f}$ = **20.9** kN/m

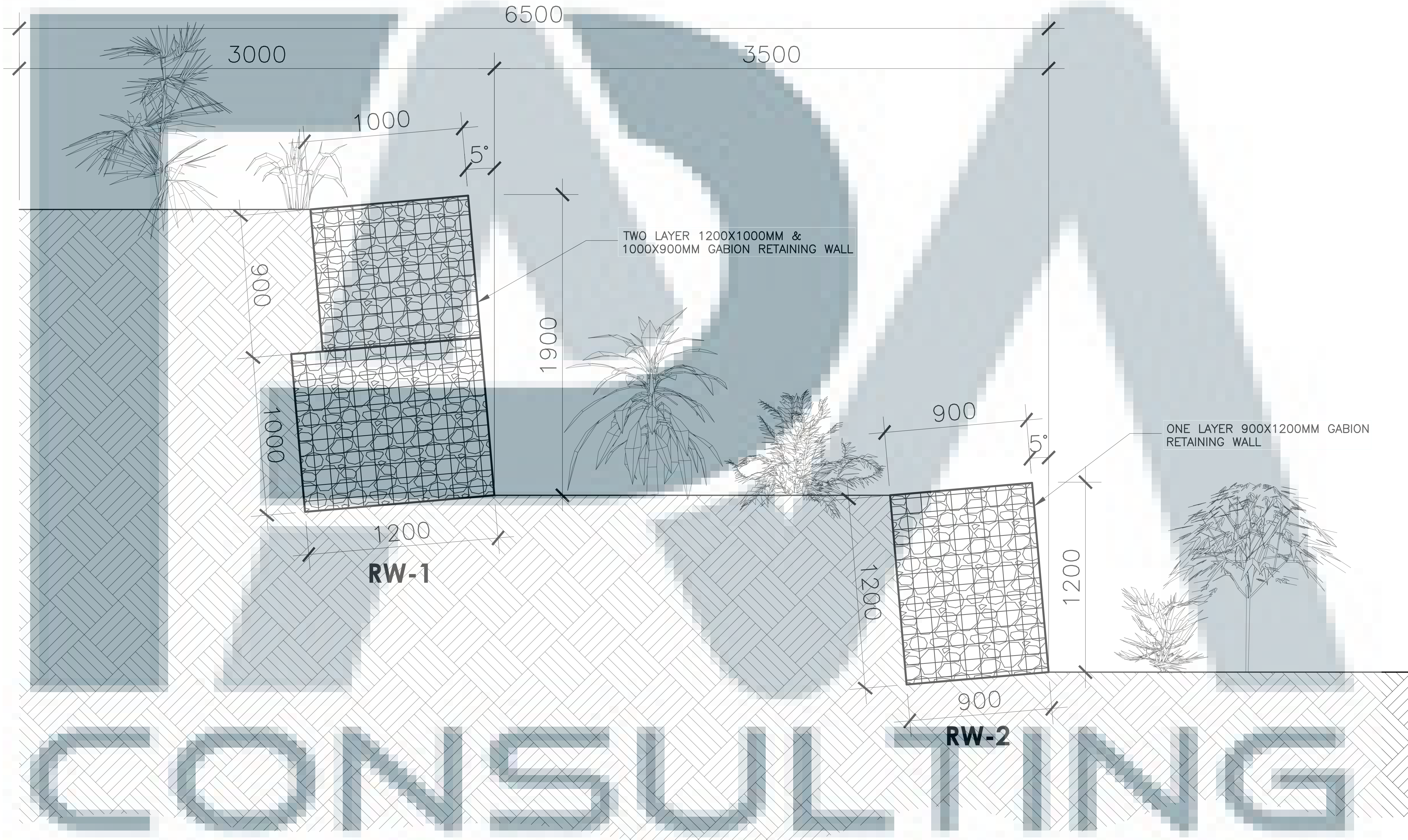
Sliding force $F_f = T \times \cos(\varepsilon) - N \times \sin(\varepsilon)$ = **7.5** kN/m

Sliding resistance $F_R = (T \times \sin(\varepsilon) + N \times \cos(\varepsilon)) \times \tan(\delta_{bb.d})$ = **11.6** kN/m

Factor of safety $FoS_S = F_R / F_f$ = **1.547**

Allowable factor of safety FoS_{S_allow} = **1.000**

PASS - Design FOS for sliding exceeds min allowable FOS for sliding



RETAINING WALL SECTION/ELEVATION

SCALE 1 : 25M

NOTES:

1. ALL DIMENSIONS HEREIN ARE IN MILLIMETERS UNLESS STATED OTHERWISE.

2. THESE DRAWINGS ARE TO BE READ IN CONJUNCTION WITH ALL RELEVANT DESIGNER, ENGINEER OR SPECIALIST DRAWINGS AND SPECIFICATIONS.

3. THE CONTRACTOR MUST CHECK ALL DIMENSION AT SITE BEFORE COMMENCING WORK.

4. THE CONTRACTOR IS RESPONSIBLE FOR PROVIDING ALL NECESSARY TEMPORARY SUPPORT TO THE BUILDING AND ANY ADJACENT STRUCTURES.

PROJECT TITLE:

PROPOSED GABION RETAINING WALL

ADDRESS:

73 RICHARDSON ROAD,
THORNABY TS17 8QE

CLIENT:

SHEET CONTENT:

GABION RETAINING WALL ELEVATION/SECTION

SCALE @ A3 SIZE: 1:25MTRS

SHEET NUMBER:

S - 0 1

WELDED MESH GABION SPECIFICATION

GABION 27 SYSTEM – GALFAN COATED

GABIONS SHALL COMPLY WITH THE FOLLOWING SPECIFICATIONS:

MANUFACTURE:	GABIONS SHALL BE MANUFACTURED FROM A HARD DRAWN STEEL WIRE FORMED INTO A BI–AXIAL MESH GRID BY ELECTRICALLY WELDING THE CROSS WIRES AT EVERY INTERSECTION. THE WELD STRENGTH IS TO BE 70% OF THE ULTIMATE TENSILE STRENGTH OF THE WIRE. GABIONS ARE TO BE FACTORY ASSEMBLED WITH STAINLESS STEEL CLIPS (MINIMUM ONE EVERY THIRD MESH OPENING) CONNECTING SIDE PANELS AND DIAPHRAGMS TO THE BASE PANEL AND THE LID TO THE FACE PANEL. DIAPHRAGMS ARE TO BE AT 686MM CENTRES WITHIN THE UNIT AND A MAXIMUM OF 1.38M ACROSS THE WIDTH.
MESH SIZE:	THE MESH OPENINGS SHALL BE SQUARE AND OF A NOMINAL DIMENSION OF 76.2MM ON THE GRID.
MESH WIRE:	THE NOMINAL WIRE DIAMETER SHALL BE 3.0MM FOR THE BASE, ENDS, DIAPHRAGMS AND THE LID ON THE UPPER MOST UNIT AND A 4.0MM DIAMETER WIRE FOR THE FRONT AND REAR PANELS. ALL WIRE IS IN ACCORDANCE WITH BS EN 10218–3: 1997 AND OF A TENSILE STRENGTH WITHIN THE RANGE OF 540–770 N/MM2.
CORROSION PROTECTION:	WIRE SHALL BE GALFAN COATED (95% ZN / 5% AL) IN ACCORDANCE WITH BS EN 10244–2: 2001.
JOINTING:	GABIONS SHALL BE PROVIDED WITH LACING WIRE AND HELICAL SPIRALS FOR SITE ASSEMBLY. THE LACING WIRE SHALL BE OF A NOMINAL WIRE DIAMETER OF 2.2MM AND THE HELICALS OF 3.00MM (ALL IN ACCORDANCE WITH THE CORROSION PROTECTION SPECIFIED) FOR FINAL JOINTING.
ROCKFILL:	GABION FILL SHALL BE A HARD DURABLE AND NON FROST SUSCEPTIBLE (ROCK OR STONE TYPE) HAVING A MINIMUM DIMENSION OF NOT LESS THAN THE MESH OPENING AND A MAXIMUM DIMENSION OF 200MM
CONSTRUCTION:	ALL ROCK FILL SHALL BE PACKED TIGHTLY TO MINIMIZE VOIDS AND THE ROCK FILL ON THE EXPOSED FACE OF THE GABION IS TO BE HAND PACKED. CORNER BRACING TIES 2 PER FACE AND REAR CELL AT MID HEIGHT ON 686MM HIGH UNITS AND AT 4 PER FACE AND REAR CELL AT THIRD HEIGHTS ON 1M HIGH UNITS. ADJACENT UNITS ARE TO BE JOINTED WITH HELICAL SPIRALS ON THE VERTICAL JOINTS AND LACED ON THE HORIZONTAL JOINTS AT THE FRONT AND REAR OF COURSED JOINTS. UNITS SHALL BE FILLED SUCH THAT THE MESH BASE OF THE UNIT ABOVE BEARS DOWN ONTO THE ROCK FILL. THE LID SHALL BE WIRED DOWN ON ALL JOINTS AND ACROSS THE DIAPHRAGMS.

NOTES:

1. ALL DIMENSIONS HEREIN ARE IN MILLIMETERS UNLESS STATED OTHERWISE.
2. THESE DRAWINGS ARE TO BE READ IN CONJUNCTION WITH ALL RELEVANT DESIGNER, ENGINEER OR SPECIALIST DRAWINGS AND SPECIFICATIONS.
3. THE CONTRACTOR MUST CHECK ALL DIMENSION AT SITE BEFORE COMMENCING WORK.
4. THE CONTRACTOR IS RESPONSIBLE FOR PROVIDING ALL NECESSARY TEMPORARY SUPPORT TO THE BUILDING AND ANY ADJACENT STRUCTURES.

PROJECT TITLE:

PROPOSED GABION RETAINING WALL

ADDRESS:

73 RICHARDSON ROAD,
THORNABY TS17 8QE

CLIENT:

SHEET CONTENT:

SPECIFICATIONS

SCALE @ A3 SIZE: NTS

SHEET NUMBER:

S - 02