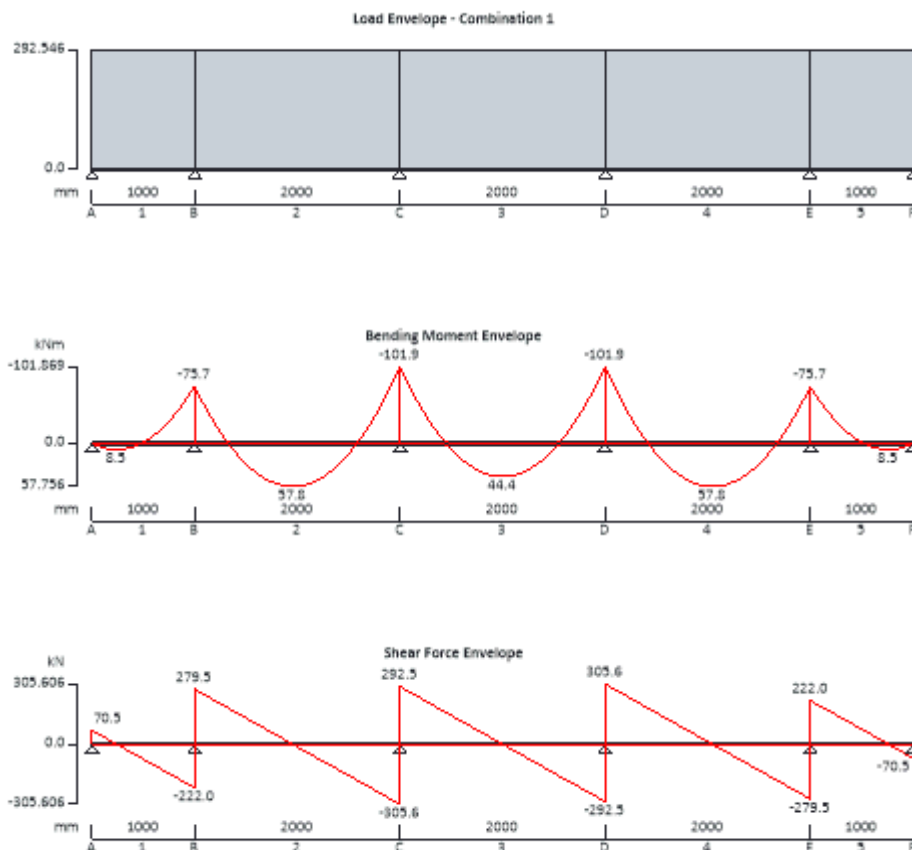


Project Kingsley Terrace Aberfan				Job no. 22023	
Calcs for Piled retaining wall base				Start page no./Revision 1 0	
Calcs by EKA	Calcs date 22/05/2023	Checked by SW	Checked date 22/05/2023	Approved by SW	Approved date 22/05/2023

RC BEAM ANALYSIS & DESIGN BS8110

TEDDS calculation version 2.1.14



Support conditions

Support A	Vertically restrained Rotationally free
Support B	Vertically restrained Rotationally free
Support C	Vertically restrained Rotationally free
Support D	Vertically restrained Rotationally free
Support E	Vertically restrained Rotationally free
Support F	Vertically restrained Rotationally free

Applied loading

Dead self weight of beam $\times 1$
Dead full UDL 175 kN/m
Imposed full UDL 15 kN/m

Load combinations

Load combination 1	Support A	Dead $\times 1.40$
--------------------	-----------	--------------------

Project Kingsley Terrace Aberfan				Job no. 22023	
Calcs for Piled retaining wall base				Start page no./Revision 2 0	
Calcs by EKA	Calcs date 22/05/2023	Checked by SW	Checked date 22/05/2023	Approved by SW	Approved date 22/05/2023

	Imposed × 1.60
Span 1	Dead × 1.40
	Imposed × 1.60
Support B	Dead × 1.40
	Imposed × 1.60
Span 2	Dead × 1.40
	Imposed × 1.60
Support C	Dead × 1.40
	Imposed × 1.60
Span 3	Dead × 1.40
	Imposed × 1.60
Support D	Dead × 1.40
	Imposed × 1.60
Span 4	Dead × 1.40
	Imposed × 1.60
Support E	Dead × 1.40
	Imposed × 1.60
Span 5	Dead × 1.40
	Imposed × 1.60
Support F	Dead × 1.40
	Imposed × 1.60

Analysis results

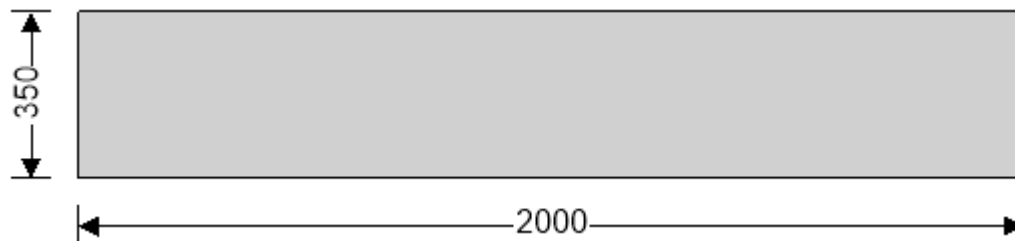
Maximum moment support A	$M_{A_max} = 0 \text{ kNm}$	$M_{A_red} = 0 \text{ kNm}$
Maximum moment span 1 at 241 mm	$M_{s1_max} = 9 \text{ kNm}$	$M_{s1_red} = 9 \text{ kNm}$
Maximum moment support B	$M_{B_max} = -76 \text{ kNm}$	$M_{B_red} = -76 \text{ kNm}$
Maximum moment span 2 at 955 mm	$M_{s2_max} = 58 \text{ kNm}$	$M_{s2_red} = 58 \text{ kNm}$
Maximum moment support C	$M_{C_max} = -102 \text{ kNm}$	$M_{C_red} = -102 \text{ kNm}$
Maximum moment span 3 at 1000 mm	$M_{s3_max} = 44 \text{ kNm}$	$M_{s3_red} = 44 \text{ kNm}$
Maximum moment support D	$M_{D_max} = -102 \text{ kNm}$	$M_{D_red} = -102 \text{ kNm}$
Maximum moment span 4 at 1045 mm	$M_{s4_max} = 58 \text{ kNm}$	$M_{s4_red} = 58 \text{ kNm}$
Maximum moment support E	$M_{E_max} = -76 \text{ kNm}$	$M_{E_red} = -76 \text{ kNm}$
Maximum moment span 5 at 759 mm	$M_{s5_max} = 9 \text{ kNm}$	$M_{s5_red} = 9 \text{ kNm}$
Maximum moment support F	$M_{F_max} = 0 \text{ kNm}$	$M_{F_red} = 0 \text{ kNm}$
Maximum shear support A	$V_{A_max} = 71 \text{ kN}$	$V_{A_red} = 71 \text{ kN}$
Maximum shear support A span 1 at 292 mm	$V_{A_s1_max} = -15 \text{ kN}$	$V_{A_s1_red} = -15 \text{ kN}$
Maximum shear support B	$V_{B_max} = 279 \text{ kN}$	$V_{B_red} = 279 \text{ kN}$
Maximum shear support B span 1 at 708 mm	$V_{B_s1_max} = -137 \text{ kN}$	$V_{B_s1_red} = -137 \text{ kN}$
Maximum shear support B span 2 at 292 mm	$V_{B_s2_max} = 194 \text{ kN}$	$V_{B_s2_red} = 194 \text{ kN}$
Maximum shear support C	$V_{C_max} = -306 \text{ kN}$	$V_{C_red} = -306 \text{ kN}$
Maximum shear support C span 2 at 1708 mm	$V_{C_s2_max} = -220 \text{ kN}$	$V_{C_s2_red} = -220 \text{ kN}$
Maximum shear support C span 3 at 292 mm	$V_{C_s3_max} = 207 \text{ kN}$	$V_{C_s3_red} = 207 \text{ kN}$
Maximum shear support D	$V_{D_max} = 306 \text{ kN}$	$V_{D_red} = 306 \text{ kN}$
Maximum shear support D span 3 at 1708 mm	$V_{D_s3_max} = -207 \text{ kN}$	$V_{D_s3_red} = -207 \text{ kN}$
Maximum shear support D span 4 at 292 mm	$V_{D_s4_max} = 220 \text{ kN}$	$V_{D_s4_red} = 220 \text{ kN}$
Maximum shear support E	$V_{E_max} = -279 \text{ kN}$	$V_{E_red} = -279 \text{ kN}$
Maximum shear support E span 4 at 1708 mm	$V_{E_s4_max} = -194 \text{ kN}$	$V_{E_s4_red} = -194 \text{ kN}$

Project Kingsley Terrace Aberfan				Job no. 22023	
Calcs for Piled retaining wall base				Start page no./Revision 3 0	
Calcs by EKA	Calcs date 22/05/2023	Checked by SW	Checked date 22/05/2023	Approved by SW	Approved date 22/05/2023

Maximum shear support E span 5 at 292 mm	$V_{E_s5_max} = 137 \text{ kN}$	$V_{E_s5_red} = 137 \text{ kN}$
Maximum shear support F	$V_{F_max} = -71 \text{ kN}$	$V_{F_red} = -71 \text{ kN}$
Maximum shear support F span 5 at 708 mm	$V_{F_s5_max} = 15 \text{ kN}$	$V_{F_s5_red} = 15 \text{ kN}$
Maximum reaction at support A	$R_A = 71 \text{ kN}$	
Unfactored dead load reaction at support A	$R_{A_Dead} = 46 \text{ kN}$	
Unfactored imposed load reaction at support A	$R_{A_Imposed} = 4 \text{ kN}$	
Maximum reaction at support B	$R_B = 502 \text{ kN}$	
Unfactored dead load reaction at support B	$R_{B_Dead} = 329 \text{ kN}$	
Unfactored imposed load reaction at support B	$R_{B_Imposed} = 26 \text{ kN}$	
Maximum reaction at support C	$R_C = 598 \text{ kN}$	
Unfactored dead load reaction at support C	$R_{C_Dead} = 392 \text{ kN}$	
Unfactored imposed load reaction at support C	$R_{C_Imposed} = 31 \text{ kN}$	
Maximum reaction at support D	$R_D = 598 \text{ kN}$	
Unfactored dead load reaction at support D	$R_{D_Dead} = 392 \text{ kN}$	
Unfactored imposed load reaction at support D	$R_{D_Imposed} = 31 \text{ kN}$	
Maximum reaction at support E	$R_E = 502 \text{ kN}$	
Unfactored dead load reaction at support E	$R_{E_Dead} = 329 \text{ kN}$	
Unfactored imposed load reaction at support E	$R_{E_Imposed} = 26 \text{ kN}$	
Maximum reaction at support F	$R_F = 71 \text{ kN}$	
Unfactored dead load reaction at support F	$R_{F_Dead} = 46 \text{ kN}$	
Unfactored imposed load reaction at support F	$R_{F_Imposed} = 4 \text{ kN}$	

Rectangular section details

Section width	$b = 2000 \text{ mm}$
Section depth	$h = 350 \text{ mm}$



Concrete details

Concrete strength class	C28/35
Characteristic compressive cube strength	$f_{cu} = 35 \text{ N/mm}^2$
Modulus of elasticity of concrete	$E_c = 20 \text{ kN/mm}^2 + 200 \times f_{cu} = 27000 \text{ N/mm}^2$
Maximum aggregate size	$h_{agg} = 20 \text{ mm}$

Reinforcement details

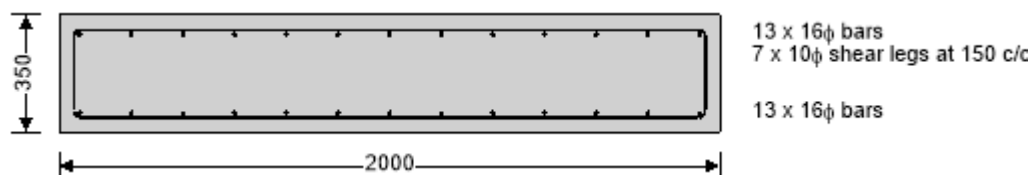
Characteristic yield strength of reinforcement	$f_y = 500 \text{ N/mm}^2$
Characteristic yield strength of shear reinforcement	$f_{yv} = 500 \text{ N/mm}^2$

Nominal cover to reinforcement

Nominal cover to top reinforcement	$C_{nom_t} = 40 \text{ mm}$
Nominal cover to bottom reinforcement	$C_{nom_b} = 40 \text{ mm}$
Nominal cover to side reinforcement	$C_{nom_s} = 40 \text{ mm}$

Project Kingsley Terrace Aberfan				Job no. 22023	
Calcs for Piled retaining wall base				Start page no./Revision 4 0	
Calcs by EKA	Calcs date 22/05/2023	Checked by SW	Checked date 22/05/2023	Approved by SW	Approved date 22/05/2023

Support A



Rectangular section in shear

Design shear force span 1 at 292 mm

$$V = \text{abs}(\min(V_{A_s1_max}, V_{A_s1_red})) = 15 \text{ kN}$$

Design shear stress

$$v = V / (b \times d) = 0.026 \text{ N/mm}^2$$

Design concrete shear stress

$$v_c = 0.79 \times \min(3, [100 \times A_{s,prov} / (b \times d)]^{1/3}) \times \max(1, (400 / d)^{1/4}) \times$$

$(\min(f_{cu}, 40) / 25)^{1/3} / \gamma_m$

$$v_c = 0.585 \text{ N/mm}^2$$

Allowable design shear stress

$$v_{max} = \min(0.8 \text{ N/mm}^2 \times (f_{cu} / 1 \text{ N/mm}^2)^{0.5}, 5 \text{ N/mm}^2) = 4.733 \text{ N/mm}^2$$

PASS - Design shear stress is less than maximum allowable

Value of v from Table 3.7

$$v < 0.5v_c$$

Design shear resistance required

$$v_s = \max(v - v_c, 0.4 \text{ N/mm}^2) = 0.400 \text{ N/mm}^2$$

Area of shear reinforcement required

$$A_{sv,req} = v_s \times b / (0.87 \times f_{yv}) = 1839 \text{ mm}^2/\text{m}$$

Shear reinforcement provided

$$7 \times 10\phi \text{ legs at } 150 \text{ c/c}$$

Area of shear reinforcement provided

$$A_{sv,prov} = 3665 \text{ mm}^2/\text{m}$$

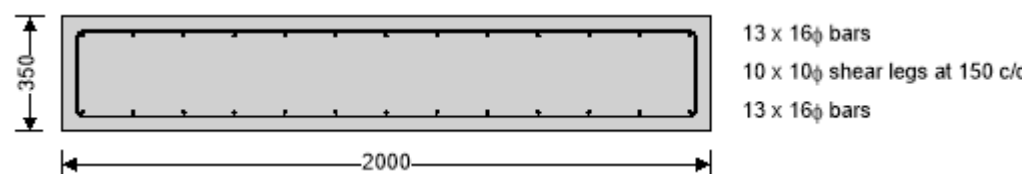
PASS - Area of shear reinforcement provided exceeds minimum required

Maximum longitudinal spacing

$$s_{vl,max} = 0.75 \times d = 219 \text{ mm}$$

PASS - Longitudinal spacing of shear reinforcement provided is less than maximum

Mid span 1



Design moment resistance of rectangular section (cl. 3.4.4) - Positive moment

Design bending moment

$$M = \text{abs}(M_{s1_red}) = 9 \text{ kNm}$$

Depth to tension reinforcement

$$d = h - c_{nom_b} - \phi_v - \phi_{bot} / 2 = 292 \text{ mm}$$

Redistribution ratio

$$\beta_b = \min(1 - m_{rs1}, 1) = 1.000$$

$$K = M / (b \times d^2 \times f_{cu}) = 0.001$$

$$K' = 0.156$$

K' > K - No compression reinforcement is required

Lever arm

$$z = \min(d \times (0.5 + (0.25 - K / 0.9)^{0.5}), 0.95 \times d) = 277 \text{ mm}$$

Depth of neutral axis

$$x = (d - z) / 0.45 = 32 \text{ mm}$$

Area of tension reinforcement required

$$A_{s,req} = M / (0.87 \times f_y \times z) = 70 \text{ mm}^2$$

Tension reinforcement provided

$$13 \times 16\phi \text{ bars}$$

Area of tension reinforcement provided

$$A_{s,prov} = 2614 \text{ mm}^2$$

Minimum area of reinforcement

$$A_{s,min} = 0.0013 \times b \times h = 910 \text{ mm}^2$$

Maximum area of reinforcement

$$A_{s,max} = 0.04 \times b \times h = 28000 \text{ mm}^2$$

PASS - Area of reinforcement provided is greater than area of reinforcement required

Project Kingsley Terrace Aberfan				Job no. 22023	
Calcs for Piled retaining wall base				Start page no./Revision 5 0	
Calcs by EKA	Calcs date 22/05/2023	Checked by SW	Checked date 22/05/2023	Approved by SW	Approved date 22/05/2023

Rectangular section in shear

Shear reinforcement provided	$10 \times 10\phi$ legs at 150 c/c
Area of shear reinforcement provided	$A_{sv,prov} = 5236 \text{ mm}^2/\text{m}$
Minimum area of shear reinforcement (Table 3.7)	$A_{sv,min} = 0.4N/\text{mm}^2 \times b / (0.87 \times f_{yv}) = 1839 \text{ mm}^2/\text{m}$
<i>PASS - Area of shear reinforcement provided exceeds minimum required</i>	
Maximum longitudinal spacing (cl. 3.4.5.5)	$S_{vl,max} = 0.75 \times d = 219 \text{ mm}$
<i>PASS - Longitudinal spacing of shear reinforcement provided is less than maximum</i>	
Design concrete shear stress	$v_c = 0.79N/\text{mm}^2 \times \min(3, [100 \times A_{s,prov} / (b \times d)]^{1/3}) \times \max(1, (400\text{mm} / d)^{1/4}) \times (\min(f_{cu}, 40N/\text{mm}^2) / 25N/\text{mm}^2)^{1/3} / \gamma_m = 0.585 \text{ N/mm}^2$
Design shear resistance provided	$V_{s,prov} = A_{sv,prov} \times 0.87 \times f_{yv} / b = 1.139 \text{ N/mm}^2$
Design shear stress provided	$V_{prov} = V_{s,prov} + v_c = 1.724 \text{ N/mm}^2$
Design shear resistance	$V_{prov} = V_{prov} \times (b \times d) = 1006.8 \text{ kN}$
<i>Shear links provided valid between 0 mm and 1000 mm with tension reinforcement of 2614 mm²</i>	

Spacing of reinforcement (cl 3.12.11)

Actual distance between bars in tension	$s = (b - 2 \times (C_{nom_s} + \phi_v + \phi_{bot}/2)) / (N_{bot} - 1) - \phi_{bot} = 141 \text{ mm}$
---	---

Minimum distance between bars in tension (cl 3.12.11.1)

Minimum distance between bars in tension	$S_{min} = h_{agg} + 5 \text{ mm} = 25 \text{ mm}$
<i>PASS - Satisfies the minimum spacing criteria</i>	

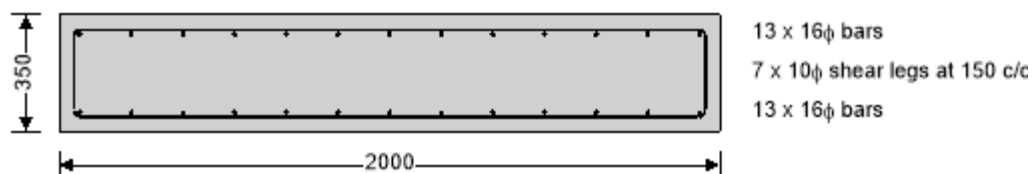
Maximum distance between bars in tension (cl 3.12.11.2)

Design service stress	$f_s = (2 \times f_y \times A_{s,req}) / (3 \times A_{s,prov} \times \beta_b) = 9.0 \text{ N/mm}^2$
Maximum distance between bars in tension	$S_{max} = \min(47000 \text{ N/mm} / f_s, 300 \text{ mm}) = 300 \text{ mm}$
<i>PASS - Satisfies the maximum spacing criteria</i>	

Span to depth ratio (cl. 3.4.6)

Basic span to depth ratio (Table 3.9)	$\text{span_to_depth}_{basic} = 26.0$
Design service stress in tension reinforcement	$f_s = (2 \times f_y \times A_{s,req}) / (3 \times A_{s,prov} \times \beta_b) = 9.0 \text{ N/mm}^2$
Modification for tension reinforcement	$f_{tens} = \min(2.0, 0.55 + (477N/\text{mm}^2 - f_s) / (120 \times (0.9N/\text{mm}^2 + (M / (b \times d^2)))) = 2.000$
Modification for compression reinforcement	$f_{comp} = \min(1.5, 1 + (100 \times A_{s2,prov} / (b \times d)) / (3 + (100 \times A_{s2,prov} / (b \times d)))) = 1.130$
Modification for span length	$f_{long} = 1.000$
Allowable span to depth ratio	$\text{span_to_depth}_{allow} = \text{span_to_depth}_{basic} \times f_{tens} \times f_{comp} = 58.8$
Actual span to depth ratio	$\text{span_to_depth}_{actual} = L_{s1} / d = 3.4$
<i>PASS - Actual span to depth ratio is within the allowable limit</i>	

Support B



Design moment resistance of rectangular section (cl. 3.4.4)

Design bending moment	$M = \text{abs}(M_{B_red}) = 76 \text{ kNm}$
Depth to tension reinforcement	$d = h - C_{nom_t} - \phi_v - \phi_{top} / 2 = 292 \text{ mm}$
Redistribution ratio	$\beta_b = \min(1 - m_{rB}, 1) = 1.000$

Project Kingsley Terrace Aberfan				Job no. 22023	
Calcs for Piled retaining wall base				Start page no./Revision 6 0	
Calcs by EKA	Calcs date 22/05/2023	Checked by SW	Checked date 22/05/2023	Approved by SW	Approved date 22/05/2023

$K = M / (b \times d^2 \times f_{cu}) = \mathbf{0.013}$
 $K' = 0.156$
 $K' > K$ - No compression reinforcement is required
 Lever arm
 $z = \min(d \times (0.5 + (0.25 - K / 0.9)^{0.5}), 0.95 \times d) = \mathbf{277 \text{ mm}}$
 Depth of neutral axis
 $x = (d - z) / 0.45 = \mathbf{32 \text{ mm}}$
 Area of tension reinforcement required
 $A_{s,req} = M / (0.87 \times f_y \times z) = \mathbf{628 \text{ mm}^2}$
 Tension reinforcement provided
 $13 \times 16\phi \text{ bars}$
 Area of tension reinforcement provided
 $A_{s,prov} = \mathbf{2614 \text{ mm}^2}$
 Minimum area of reinforcement
 $A_{s,min} = 0.0013 \times b \times h = \mathbf{910 \text{ mm}^2}$
 Maximum area of reinforcement
 $A_{s,max} = 0.04 \times b \times h = \mathbf{28000 \text{ mm}^2}$
PASS - Area of reinforcement provided is greater than area of reinforcement required

Rectangular section in shear

Design shear force span 1 at 708 mm
 $V = \text{abs}(\min(V_{B_s1_max}, V_{B_s1_red})) = \mathbf{137 \text{ kN}}$
 Design shear stress
 $v = V / (b \times d) = \mathbf{0.234 \text{ N/mm}^2}$
 Design concrete shear stress
 $v_c = 0.79 \times \min(3, [100 \times A_{s,prov} / (b \times d)]^{1/3}) \times \max(1, (400 / d)^{1/4}) \times$
 $(\min(f_{cu}, 40) / 25)^{1/3} / \gamma_m$
 $v_c = \mathbf{0.585 \text{ N/mm}^2}$
 Allowable design shear stress
 $v_{max} = \min(0.8 \text{ N/mm}^2 \times (f_{cu} / 1 \text{ N/mm}^2)^{0.5}, 5 \text{ N/mm}^2) = \mathbf{4.733 \text{ N/mm}^2}$
PASS - Design shear stress is less than maximum allowable
 Value of v from Table 3.7
 $v < 0.5v_c$
 Design shear resistance required
 $v_s = \max(v - v_c, 0.4 \text{ N/mm}^2) = \mathbf{0.400 \text{ N/mm}^2}$
 Area of shear reinforcement required
 $A_{sv,req} = v_s \times b / (0.87 \times f_{yv}) = \mathbf{1839 \text{ mm}^2/m}$
 Shear reinforcement provided
 $7 \times 10\phi \text{ legs at } 150 \text{ c/c}$
 Area of shear reinforcement provided
 $A_{sv,prov} = \mathbf{3665 \text{ mm}^2/m}$
PASS - Area of shear reinforcement provided exceeds minimum required

Maximum longitudinal spacing
 $s_{vl,max} = 0.75 \times d = \mathbf{219 \text{ mm}}$
PASS - Longitudinal spacing of shear reinforcement provided is less than maximum
 Design shear force span 2 at 292 mm
 $V = \max(V_{B_s2_max}, V_{B_s2_red}) = \mathbf{194 \text{ kN}}$
 Design shear stress
 $v = V / (b \times d) = \mathbf{0.332 \text{ N/mm}^2}$
 Design concrete shear stress
 $v_c = 0.79 \times \min(3, [100 \times A_{s,prov} / (b \times d)]^{1/3}) \times \max(1, (400 / d)^{1/4}) \times$
 $(\min(f_{cu}, 40) / 25)^{1/3} / \gamma_m$
 $v_c = \mathbf{0.585 \text{ N/mm}^2}$
 Allowable design shear stress
 $v_{max} = \min(0.8 \text{ N/mm}^2 \times (f_{cu} / 1 \text{ N/mm}^2)^{0.5}, 5 \text{ N/mm}^2) = \mathbf{4.733 \text{ N/mm}^2}$
PASS - Design shear stress is less than maximum allowable
 Value of v from Table 3.7
 $0.5 \times v_c < v < (v_c + 0.4 \text{ N/mm}^2)$
 Design shear resistance required
 $v_s = \max(v - v_c, 0.4 \text{ N/mm}^2) = \mathbf{0.400 \text{ N/mm}^2}$
 Area of shear reinforcement required
 $A_{sv,req} = v_s \times b / (0.87 \times f_{yv}) = \mathbf{1839 \text{ mm}^2/m}$
 Shear reinforcement provided
 $7 \times 10\phi \text{ legs at } 150 \text{ c/c}$
 Area of shear reinforcement provided
 $A_{sv,prov} = \mathbf{3665 \text{ mm}^2/m}$
PASS - Area of shear reinforcement provided exceeds minimum required
 Maximum longitudinal spacing
 $s_{vl,max} = 0.75 \times d = \mathbf{219 \text{ mm}}$
PASS - Longitudinal spacing of shear reinforcement provided is less than maximum

Spacing of reinforcement (cl 3.12.11)

Actual distance between bars in tension
 $s = (b - 2 \times (C_{nom_s} + \phi_v + \phi_{top}/2)) / (N_{top} - 1) - \phi_{top} = \mathbf{141 \text{ mm}}$

Project Kingsley Terrace Aberfan				Job no. 22023	
Calcs for Piled retaining wall base				Start page no./Revision 7 0	
Calcs by EKA	Calcs date 22/05/2023	Checked by SW	Checked date 22/05/2023	Approved by SW	Approved date 22/05/2023

Minimum distance between bars in tension (cl 3.12.11.1)

Minimum distance between bars in tension $s_{min} = h_{agg} + 5 \text{ mm} = 25 \text{ mm}$

PASS - Satisfies the minimum spacing criteria

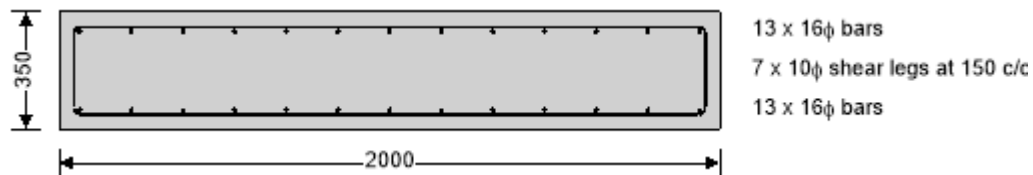
Maximum distance between bars in tension (cl 3.12.11.2)

Design service stress $f_s = (2 \times f_y \times A_{s,req}) / (3 \times A_{s,prov} \times \beta_b) = 80.1 \text{ N/mm}^2$

Maximum distance between bars in tension $s_{max} = \min(47000 \text{ N/mm} / f_s, 300 \text{ mm}) = 300 \text{ mm}$

PASS - Satisfies the maximum spacing criteria

Mid span 2



Design moment resistance of rectangular section (cl. 3.4.4) - Positive moment

Design bending moment $M = \text{abs}(M_{s2_red}) = 58 \text{ kNm}$

Depth to tension reinforcement $d = h - c_{nom_b} - \phi_v - \phi_{bot} / 2 = 292 \text{ mm}$

Redistribution ratio $\beta_b = \min(1 - m_{rs2}, 1) = 1.000$

$K = M / (b \times d^2 \times f_{cu}) = 0.010$

$K' = 0.156$

$K' > K$ - No compression reinforcement is required

Lever arm $z = \min(d \times (0.5 + (0.25 - K / 0.9)^{0.5}), 0.95 \times d) = 277 \text{ mm}$

Depth of neutral axis $x = (d - z) / 0.45 = 32 \text{ mm}$

Area of tension reinforcement required $A_{s,req} = M / (0.87 \times f_y \times z) = 479 \text{ mm}^2$

Tension reinforcement provided $13 \times 16\phi \text{ bars}$

Area of tension reinforcement provided $A_{s,prov} = 2614 \text{ mm}^2$

Minimum area of reinforcement $A_{s,min} = 0.0013 \times b \times h = 910 \text{ mm}^2$

Maximum area of reinforcement $A_{s,max} = 0.04 \times b \times h = 28000 \text{ mm}^2$

PASS - Area of reinforcement provided is greater than area of reinforcement required

Rectangular section in shear

Shear reinforcement provided $7 \times 10\phi \text{ legs at } 150 \text{ c/c}$

Area of shear reinforcement provided $A_{sv,prov} = 3665 \text{ mm}^2/\text{m}$

Minimum area of shear reinforcement (Table 3.7) $A_{sv,min} = 0.4 \text{ N/mm}^2 \times b / (0.87 \times f_{yv}) = 1839 \text{ mm}^2/\text{m}$

PASS - Area of shear reinforcement provided exceeds minimum required

Maximum longitudinal spacing (cl. 3.4.5.5) $s_{vl,max} = 0.75 \times d = 219 \text{ mm}$

PASS - Longitudinal spacing of shear reinforcement provided is less than maximum

Design concrete shear stress $v_c = 0.79 \text{ N/mm}^2 \times \min(3, [100 \times A_{s,prov} / (b \times d)]^{1/3}) \times \max(1, (400 \text{ mm} / d)^{1/4}) \times (\min(f_{cu}, 40 \text{ N/mm}^2) / 25 \text{ N/mm}^2)^{1/3} / \gamma_m = 0.585 \text{ N/mm}^2$

Design shear resistance provided $V_{s,prov} = A_{sv,prov} \times 0.87 \times f_{yv} / b = 0.797 \text{ N/mm}^2$

Design shear stress provided $V_{prov} = V_{s,prov} + v_c = 1.382 \text{ N/mm}^2$

Design shear resistance $V_{prov} = V_{prov} \times (b \times d) = 807.2 \text{ kN}$

Shear links provided valid between 0 mm and 2000 mm with tension reinforcement of 2614 mm²

Spacing of reinforcement (cl 3.12.11)

Actual distance between bars in tension $s = (b - 2 \times (c_{nom_s} + \phi_v + \phi_{bot}/2)) / (N_{bot} - 1) - \phi_{bot} = 141 \text{ mm}$

Project Kingsley Terrace Aberfan				Job no. 22023	
Calcs for Piled retaining wall base				Start page no./Revision 8 0	
Calcs by EKA	Calcs date 22/05/2023	Checked by SW	Checked date 22/05/2023	Approved by SW	Approved date 22/05/2023

Minimum distance between bars in tension (cl 3.12.11.1)

Minimum distance between bars in tension $s_{min} = h_{agg} + 5 \text{ mm} = \mathbf{25 \text{ mm}}$

PASS - Satisfies the minimum spacing criteria

Maximum distance between bars in tension (cl 3.12.11.2)

Design service stress $f_s = (2 \times f_y \times A_{s,req}) / (3 \times A_{s,prov} \times \beta_b) = \mathbf{61.0 \text{ N/mm}^2}$

Maximum distance between bars in tension $s_{max} = \min(47000 \text{ N/mm} / f_s, 300 \text{ mm}) = \mathbf{300 \text{ mm}}$

PASS - Satisfies the maximum spacing criteria

Span to depth ratio (cl. 3.4.6)

Basic span to depth ratio (Table 3.9) $\text{span_to_depth}_{basic} = \mathbf{26.0}$

Design service stress in tension reinforcement $f_s = (2 \times f_y \times A_{s,req}) / (3 \times A_{s,prov} \times \beta_b) = \mathbf{61.0 \text{ N/mm}^2}$

Modification for tension reinforcement

$$f_{tens} = \min(2.0, 0.55 + (477 \text{ N/mm}^2 - f_s) / (120 \times (0.9 \text{ N/mm}^2 + (M / (b \times d^2)))) = \mathbf{2.000}$$

Modification for compression reinforcement

$$f_{comp} = \min(1.5, 1 + (100 \times A_{s2,prov} / (b \times d)) / (3 + (100 \times A_{s2,prov} / (b \times d)))) = \mathbf{1.130}$$

Modification for span length

$$f_{long} = \mathbf{1.000}$$

Allowable span to depth ratio

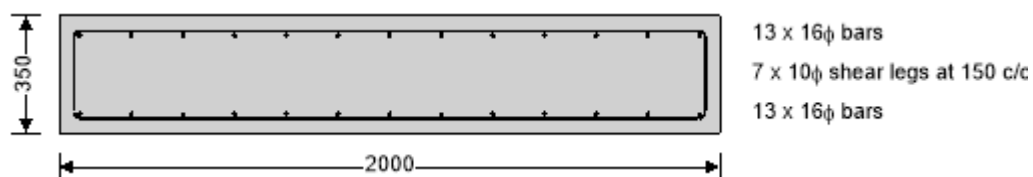
$$\text{span_to_depth}_{allow} = \text{span_to_depth}_{basic} \times f_{tens} \times f_{comp} = \mathbf{58.8}$$

Actual span to depth ratio

$$\text{span_to_depth}_{actual} = L_{s2} / d = \mathbf{6.8}$$

PASS - Actual span to depth ratio is within the allowable limit

Support C



Design moment resistance of rectangular section (cl. 3.4.4)

Design bending moment $M = \text{abs}(M_{c_red}) = \mathbf{102 \text{ kNm}}$

Depth to tension reinforcement $d = h - c_{nom_t} - \phi_v - \phi_{top} / 2 = \mathbf{292 \text{ mm}}$

Redistribution ratio $\beta_b = \min(1 - m_{rc}, 1) = \mathbf{1.000}$

$$K = M / (b \times d^2 \times f_{cu}) = \mathbf{0.017}$$

$$K' = \mathbf{0.156}$$

K' > K - No compression reinforcement is required

Lever arm $z = \min(d \times (0.5 + (0.25 - K / 0.9)^{0.5}), 0.95 \times d) = \mathbf{277 \text{ mm}}$

Depth of neutral axis $x = (d - z) / 0.45 = \mathbf{32 \text{ mm}}$

Area of tension reinforcement required $A_{s,req} = M / (0.87 \times f_y \times z) = \mathbf{844 \text{ mm}^2}$

Tension reinforcement provided $\mathbf{13 \times 16\phi \text{ bars}}$

Area of tension reinforcement provided $A_{s,prov} = \mathbf{2614 \text{ mm}^2}$

Minimum area of reinforcement $A_{s,min} = 0.0013 \times b \times h = \mathbf{910 \text{ mm}^2}$

Maximum area of reinforcement $A_{s,max} = 0.04 \times b \times h = \mathbf{28000 \text{ mm}^2}$

PASS - Area of reinforcement provided is greater than area of reinforcement required

Rectangular section in shear

Design shear force span 2 at 1708 mm $V = \text{abs}(\min(V_{c_s2_max}, V_{c_s2_red})) = \mathbf{220 \text{ kN}}$

Design shear stress $v = V / (b \times d) = \mathbf{0.377 \text{ N/mm}^2}$

Design concrete shear stress $v_c = 0.79 \times \min(3, [100 \times A_{s,prov} / (b \times d)]^{1/3}) \times \max(1, (400 / d)^{1/4}) \times (\min(f_{cu}, 40) / 25)^{1/3} / \gamma_m$

Project Kingsley Terrace Aberfan				Job no. 22023	
Calcs for Piled retaining wall base				Start page no./Revision 9 0	
Calcs by EKA	Calcs date 22/05/2023	Checked by SW	Checked date 22/05/2023	Approved by SW	Approved date 22/05/2023

Allowable design shear stress $v_c = 0.585 \text{ N/mm}^2$
 $v_{max} = \min(0.8 \text{ N/mm}^2 \times (f_{cu}/1 \text{ N/mm}^2)^{0.5}, 5 \text{ N/mm}^2) = 4.733 \text{ N/mm}^2$
PASS - Design shear stress is less than maximum allowable

Value of v from Table 3.7 $0.5 \times v_c < v < (v_c + 0.4 \text{ N/mm}^2)$
Design shear resistance required $v_s = \max(v - v_c, 0.4 \text{ N/mm}^2) = 0.400 \text{ N/mm}^2$
Area of shear reinforcement required $A_{sv,req} = v_s \times b / (0.87 \times f_{yv}) = 1839 \text{ mm}^2/\text{m}$
Shear reinforcement provided $7 \times 10\phi$ legs at 150 c/c
Area of shear reinforcement provided $A_{sv,prov} = 3665 \text{ mm}^2/\text{m}$
PASS - Area of shear reinforcement provided exceeds minimum required

Maximum longitudinal spacing $s_{vl,max} = 0.75 \times d = 219 \text{ mm}$
PASS - Longitudinal spacing of shear reinforcement provided is less than maximum

Design shear force span 3 at 292 mm $V = \max(V_{C_s3_max}, V_{C_s3_red}) = 207 \text{ kN}$
Design shear stress $v = V / (b \times d) = 0.355 \text{ N/mm}^2$
Design concrete shear stress $v_c = 0.79 \times \min(3, [100 \times A_{sv,prov} / (b \times d)]^{1/3}) \times \max(1, (400/d)^{1/4}) \times$
 $(\min(f_{cu}, 40) / 25)^{1/3} / \gamma_m$

Allowable design shear stress $v_c = 0.585 \text{ N/mm}^2$
 $v_{max} = \min(0.8 \text{ N/mm}^2 \times (f_{cu}/1 \text{ N/mm}^2)^{0.5}, 5 \text{ N/mm}^2) = 4.733 \text{ N/mm}^2$
PASS - Design shear stress is less than maximum allowable

Value of v from Table 3.7 $0.5 \times v_c < v < (v_c + 0.4 \text{ N/mm}^2)$
Design shear resistance required $v_s = \max(v - v_c, 0.4 \text{ N/mm}^2) = 0.400 \text{ N/mm}^2$
Area of shear reinforcement required $A_{sv,req} = v_s \times b / (0.87 \times f_{yv}) = 1839 \text{ mm}^2/\text{m}$
Shear reinforcement provided $7 \times 10\phi$ legs at 150 c/c
Area of shear reinforcement provided $A_{sv,prov} = 3665 \text{ mm}^2/\text{m}$
PASS - Area of shear reinforcement provided exceeds minimum required

Maximum longitudinal spacing $s_{vl,max} = 0.75 \times d = 219 \text{ mm}$
PASS - Longitudinal spacing of shear reinforcement provided is less than maximum

Spacing of reinforcement (cl 3.12.11)

Actual distance between bars in tension $s = (b - 2 \times (C_{nom_s} + \phi_v + \phi_{top}/2)) / (N_{top} - 1) - \phi_{top} = 141 \text{ mm}$

Minimum distance between bars in tension (cl 3.12.11.1)

Minimum distance between bars in tension $s_{min} = h_{agg} + 5 \text{ mm} = 25 \text{ mm}$

PASS - Satisfies the minimum spacing criteria

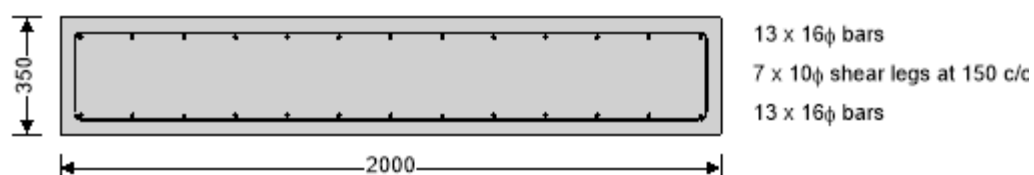
Maximum distance between bars in tension (cl 3.12.11.2)

Design service stress $f_s = (2 \times f_y \times A_{s,req}) / (3 \times A_{s,prov} \times \beta_b) = 107.7 \text{ N/mm}^2$

Maximum distance between bars in tension $s_{max} = \min(47000 \text{ N/mm} / f_s, 300 \text{ mm}) = 300 \text{ mm}$

PASS - Satisfies the maximum spacing criteria

Mid span 3



Design moment resistance of rectangular section (cl. 3.4.4) - Positive moment

Design bending moment $M = \text{abs}(M_{s3_red}) = 44 \text{ kNm}$

Depth to tension reinforcement $d = h - C_{nom_b} - \phi_v - \phi_{bot} / 2 = 292 \text{ mm}$

Project Kingsley Terrace Aberfan				Job no. 22023	
Calcs for Piled retaining wall base				Start page no./Revision 10 0	
Calcs by EKA	Calcs date 22/05/2023	Checked by SW	Checked date 22/05/2023	Approved by SW	Approved date 22/05/2023

Redistribution ratio

$$\beta_b = \min(1 - m_{rs3}, 1) = \mathbf{1.000}$$

$$K = M / (b \times d^2 \times f_{cu}) = \mathbf{0.007}$$

$$K' = 0.156$$

K' > K - No compression reinforcement is required

Lever arm

$$z = \min(d \times (0.5 + (0.25 - K / 0.9)^{0.5}), 0.95 \times d) = \mathbf{277 \text{ mm}}$$

Depth of neutral axis

$$x = (d - z) / 0.45 = \mathbf{32 \text{ mm}}$$

Area of tension reinforcement required

$$A_{s,req} = M / (0.87 \times f_y \times z) = \mathbf{368 \text{ mm}^2}$$

Tension reinforcement provided

$$13 \times 16\phi \text{ bars}$$

Area of tension reinforcement provided

$$A_{s,prov} = \mathbf{2614 \text{ mm}^2}$$

Minimum area of reinforcement

$$A_{s,min} = 0.0013 \times b \times h = \mathbf{910 \text{ mm}^2}$$

Maximum area of reinforcement

$$A_{s,max} = 0.04 \times b \times h = \mathbf{28000 \text{ mm}^2}$$

PASS - Area of reinforcement provided is greater than area of reinforcement required

Rectangular section in shear

Shear reinforcement provided

$$7 \times 10\phi \text{ legs at } 150 \text{ c/c}$$

Area of shear reinforcement provided

$$A_{sv,prov} = \mathbf{3665 \text{ mm}^2/\text{m}}$$

Minimum area of shear reinforcement (Table 3.7)

$$A_{sv,min} = 0.4N/\text{mm}^2 \times b / (0.87 \times f_{yv}) = \mathbf{1839 \text{ mm}^2/\text{m}}$$

PASS - Area of shear reinforcement provided exceeds minimum required

Maximum longitudinal spacing (cl. 3.4.5.5)

$$S_{vl,max} = 0.75 \times d = \mathbf{219 \text{ mm}}$$

PASS - Longitudinal spacing of shear reinforcement provided is less than maximum

Design concrete shear stress

$$v_c = 0.79N/\text{mm}^2 \times \min(3, [100 \times A_{s,prov} / (b \times d)]^{1/3}) \times \max(1, (400\text{mm} / d)^{1/4}) \times (\min(f_{cu}, 40N/\text{mm}^2) / 25N/\text{mm}^2)^{1/3} / \gamma_m = \mathbf{0.585 \text{ N/mm}^2}$$

Design shear resistance provided

$$V_{s,prov} = A_{sv,prov} \times 0.87 \times f_{yv} / b = \mathbf{0.797 \text{ N/mm}^2}$$

Design shear stress provided

$$V_{prov} = V_{s,prov} + v_c = \mathbf{1.382 \text{ N/mm}^2}$$

Design shear resistance

$$V_{prov} = V_{prov} \times (b \times d) = \mathbf{807.2 \text{ kN}}$$

Shear links provided valid between 0 mm and 2000 mm with tension reinforcement of 2614 mm²

Spacing of reinforcement (cl 3.12.11)

Actual distance between bars in tension

$$s = (b - 2 \times (c_{nom,s} + \phi_v + \phi_{bot}/2)) / (N_{bot} - 1) - \phi_{bot} = \mathbf{141 \text{ mm}}$$

Minimum distance between bars in tension (cl 3.12.11.1)

Minimum distance between bars in tension

$$S_{min} = h_{agg} + 5 \text{ mm} = \mathbf{25 \text{ mm}}$$

PASS - Satisfies the minimum spacing criteria

Maximum distance between bars in tension (cl 3.12.11.2)

Design service stress

$$f_s = (2 \times f_y \times A_{s,req}) / (3 \times A_{s,prov} \times \beta_b) = \mathbf{46.9 \text{ N/mm}^2}$$

Maximum distance between bars in tension

$$S_{max} = \min(47000 \text{ N/mm} / f_s, 300 \text{ mm}) = \mathbf{300 \text{ mm}}$$

PASS - Satisfies the maximum spacing criteria

Span to depth ratio (cl. 3.4.6)

Basic span to depth ratio (Table 3.9)

$$\text{span_to_depth}_{basic} = \mathbf{26.0}$$

Design service stress in tension reinforcement

$$f_s = (2 \times f_y \times A_{s,req}) / (3 \times A_{s,prov} \times \beta_b) = \mathbf{46.9 \text{ N/mm}^2}$$

Modification for tension reinforcement

$$f_{tens} = \min(2.0, 0.55 + (477N/\text{mm}^2 - f_s) / (120 \times (0.9N/\text{mm}^2 + (M / (b \times d^2))))) = \mathbf{2.000}$$

Modification for compression reinforcement

$$f_{comp} = \min(1.5, 1 + (100 \times A_{s2,prov} / (b \times d)) / (3 + (100 \times A_{s2,prov} / (b \times d)))) = \mathbf{1.130}$$

Modification for span length

$$f_{long} = 1.000$$

Allowable span to depth ratio

$$\text{span_to_depth}_{allow} = \text{span_to_depth}_{basic} \times f_{tens} \times f_{comp} = \mathbf{58.8}$$

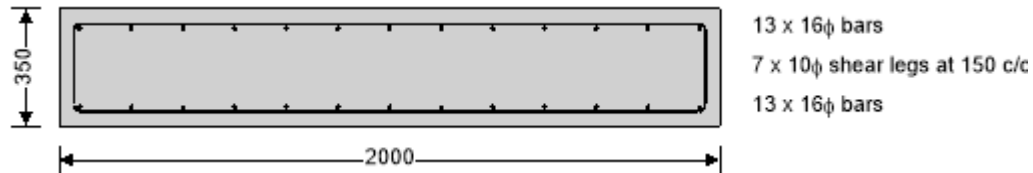
Actual span to depth ratio

$$\text{span_to_depth}_{actual} = L_{s3} / d = \mathbf{6.8}$$

PASS - Actual span to depth ratio is within the allowable limit

Project Kingsley Terrace Aberfan				Job no. 22023	
Calcs for Piled retaining wall base				Start page no./Revision 11 0	
Calcs by EKA	Calcs date 22/05/2023	Checked by SW	Checked date 22/05/2023	Approved by SW	Approved date 22/05/2023

Support D



Design moment resistance of rectangular section (cl. 3.4.4)

Design bending moment $M = \text{abs}(M_{b_red}) = 102 \text{ kNm}$

Depth to tension reinforcement $d = h - C_{nom_t} - \phi_v - \phi_{top} / 2 = 292 \text{ mm}$

Redistribution ratio $\beta_b = \min(1 - m_{RD}, 1) = 1.000$

$K = M / (b \times d^2 \times f_{cu}) = 0.017$

$K' = 0.156$

$K' > K$ - No compression reinforcement is required

Lever arm $z = \min(d \times (0.5 + (0.25 - K / 0.9)^{0.5}), 0.95 \times d) = 277 \text{ mm}$

Depth of neutral axis $x = (d - z) / 0.45 = 32 \text{ mm}$

Area of tension reinforcement required $A_{s,req} = M / (0.87 \times f_y \times z) = 844 \text{ mm}^2$

Tension reinforcement provided $13 \times 16\phi \text{ bars}$

Area of tension reinforcement provided $A_{s,prov} = 2614 \text{ mm}^2$

Minimum area of reinforcement $A_{s,min} = 0.0013 \times b \times h = 910 \text{ mm}^2$

Maximum area of reinforcement $A_{s,max} = 0.04 \times b \times h = 28000 \text{ mm}^2$

PASS - Area of reinforcement provided is greater than area of reinforcement required

Rectangular section in shear

Design shear force span 3 at 1708 mm $V = \text{abs}(\min(V_{D_s3_max}, V_{D_s3_red})) = 207 \text{ kN}$

Design shear stress $v = V / (b \times d) = 0.355 \text{ N/mm}^2$

Design concrete shear stress $v_c = 0.79 \times \min(3, [100 \times A_{s,prov} / (b \times d)]^{1/3}) \times \max(1, (400 / d)^{1/4}) \times (\min(f_{cu}, 40) / 25)^{1/3} / \gamma_m$

$v_c = 0.585 \text{ N/mm}^2$

Allowable design shear stress $v_{max} = \min(0.8 \text{ N/mm}^2 \times (f_{cu} / 1 \text{ N/mm}^2)^{0.5}, 5 \text{ N/mm}^2) = 4.733 \text{ N/mm}^2$

PASS - Design shear stress is less than maximum allowable

Value of v from Table 3.7 $0.5 \times v_c < v < (v_c + 0.4 \text{ N/mm}^2)$

Design shear resistance required $v_s = \max(v - v_c, 0.4 \text{ N/mm}^2) = 0.400 \text{ N/mm}^2$

Area of shear reinforcement required $A_{sv,req} = v_s \times b / (0.87 \times f_{yv}) = 1839 \text{ mm}^2/\text{m}$

Shear reinforcement provided $7 \times 10\phi \text{ legs at } 150 \text{ c/c}$

Area of shear reinforcement provided $A_{sv,prov} = 3665 \text{ mm}^2/\text{m}$

PASS - Area of shear reinforcement provided exceeds minimum required

Maximum longitudinal spacing $s_{vl,max} = 0.75 \times d = 219 \text{ mm}$

PASS - Longitudinal spacing of shear reinforcement provided is less than maximum

Design shear force span 4 at 292 mm $V = \max(V_{D_s4_max}, V_{D_s4_red}) = 220 \text{ kN}$

Design shear stress $v = V / (b \times d) = 0.377 \text{ N/mm}^2$

Design concrete shear stress $v_c = 0.79 \times \min(3, [100 \times A_{s,prov} / (b \times d)]^{1/3}) \times \max(1, (400 / d)^{1/4}) \times (\min(f_{cu}, 40) / 25)^{1/3} / \gamma_m$

$v_c = 0.585 \text{ N/mm}^2$

Allowable design shear stress $v_{max} = \min(0.8 \text{ N/mm}^2 \times (f_{cu} / 1 \text{ N/mm}^2)^{0.5}, 5 \text{ N/mm}^2) = 4.733 \text{ N/mm}^2$

PASS - Design shear stress is less than maximum allowable

Project Kingsley Terrace Aberfan				Job no. 22023	
Calcs for Piled retaining wall base				Start page no./Revision 12 0	
Calcs by EKA	Calcs date 22/05/2023	Checked by SW	Checked date 22/05/2023	Approved by SW	Approved date 22/05/2023

Value of v from Table 3.7 $0.5 \times v_c < v < (v_c + 0.4 \text{ N/mm}^2)$
Design shear resistance required $v_s = \max(v - v_c, 0.4 \text{ N/mm}^2) = \mathbf{0.400 \text{ N/mm}^2}$
Area of shear reinforcement required $A_{sv,req} = v_s \times b / (0.87 \times f_{yv}) = \mathbf{1839 \text{ mm}^2/\text{m}}$
Shear reinforcement provided $7 \times 10\phi$ legs at 150 c/c
Area of shear reinforcement provided $A_{sv,prov} = \mathbf{3665 \text{ mm}^2/\text{m}}$
PASS - Area of shear reinforcement provided exceeds minimum required
Maximum longitudinal spacing $s_{vl,max} = 0.75 \times d = \mathbf{219 \text{ mm}}$
PASS - Longitudinal spacing of shear reinforcement provided is less than maximum

Spacing of reinforcement (cl 3.12.11)

Actual distance between bars in tension $s = (b - 2 \times (C_{nom_s} + \phi_v + \phi_{top}/2)) / (N_{top} - 1) - \phi_{top} = \mathbf{141 \text{ mm}}$

Minimum distance between bars in tension (cl 3.12.11.1)

Minimum distance between bars in tension $s_{min} = h_{agg} + 5 \text{ mm} = \mathbf{25 \text{ mm}}$

PASS - Satisfies the minimum spacing criteria

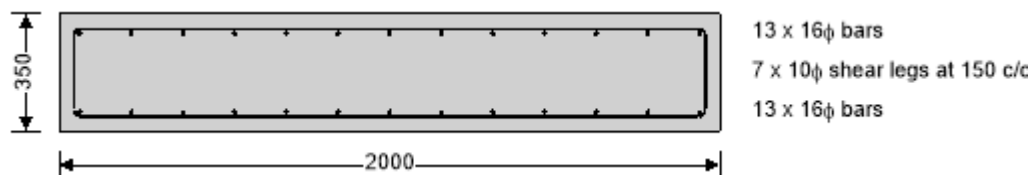
Maximum distance between bars in tension (cl 3.12.11.2)

Design service stress $f_s = (2 \times f_y \times A_{s,req}) / (3 \times A_{s,prov} \times \beta_b) = \mathbf{107.7 \text{ N/mm}^2}$

Maximum distance between bars in tension $s_{max} = \min(47000 \text{ N/mm} / f_s, 300 \text{ mm}) = \mathbf{300 \text{ mm}}$

PASS - Satisfies the maximum spacing criteria

Mid span 4



Design moment resistance of rectangular section (cl. 3.4.4) - Positive moment

Design bending moment $M = \text{abs}(M_{s4_red}) = \mathbf{58 \text{ kNm}}$

Depth to tension reinforcement $d = h - C_{nom_b} - \phi_v - \phi_{bot} / 2 = \mathbf{292 \text{ mm}}$

Redistribution ratio $\beta_b = \min(1 - m_{rs4}, 1) = \mathbf{1.000}$

$K = M / (b \times d^2 \times f_{cu}) = \mathbf{0.010}$

$K' = 0.156$

$K' > K$ - No compression reinforcement is required

Lever arm $z = \min(d \times (0.5 + (0.25 - K / 0.9)^{0.5}), 0.95 \times d) = \mathbf{277 \text{ mm}}$

Depth of neutral axis $x = (d - z) / 0.45 = \mathbf{32 \text{ mm}}$

Area of tension reinforcement required $A_{s,req} = M / (0.87 \times f_y \times z) = \mathbf{479 \text{ mm}^2}$

Tension reinforcement provided $13 \times 16\phi$ bars

Area of tension reinforcement provided $A_{s,prov} = \mathbf{2614 \text{ mm}^2}$

Minimum area of reinforcement $A_{s,min} = 0.0013 \times b \times h = \mathbf{910 \text{ mm}^2}$

Maximum area of reinforcement $A_{s,max} = 0.04 \times b \times h = \mathbf{28000 \text{ mm}^2}$

PASS - Area of reinforcement provided is greater than area of reinforcement required

Rectangular section in shear

Shear reinforcement provided $7 \times 10\phi$ legs at 150 c/c

Area of shear reinforcement provided $A_{sv,prov} = \mathbf{3665 \text{ mm}^2/\text{m}}$

Minimum area of shear reinforcement (Table 3.7) $A_{sv,min} = 0.4 \text{ N/mm}^2 \times b / (0.87 \times f_{yv}) = \mathbf{1839 \text{ mm}^2/\text{m}}$

PASS - Area of shear reinforcement provided exceeds minimum required

Maximum longitudinal spacing (cl. 3.4.5.5) $s_{vl,max} = 0.75 \times d = \mathbf{219 \text{ mm}}$

Project Kingsley Terrace Aberfan				Job no. 22023	
Calcs for Piled retaining wall base				Start page no./Revision 13 0	
Calcs by EKA	Calcs date 22/05/2023	Checked by SW	Checked date 22/05/2023	Approved by SW	Approved date 22/05/2023

PASS - Longitudinal spacing of shear reinforcement provided is less than maximum

Design concrete shear stress $v_c = 0.79 \text{ N/mm}^2 \times \min(3, [100 \times A_{s,prov} / (b \times d)]^{1/3}) \times \max(1, (400 \text{ mm} / d)^{1/4}) \times (\min(f_{cu}, 40 \text{ N/mm}^2) / 25 \text{ N/mm}^2)^{1/3} / \gamma_m = \mathbf{0.585 \text{ N/mm}^2}$

Design shear resistance provided $V_{s,prov} = A_{sv,prov} \times 0.87 \times f_{yv} / b = \mathbf{0.797 \text{ N/mm}^2}$

Design shear stress provided $V_{prov} = V_{s,prov} + v_c = \mathbf{1.382 \text{ N/mm}^2}$

Design shear resistance $V_{prov} = V_{prov} \times (b \times d) = \mathbf{807.2 \text{ kN}}$

Shear links provided valid between 0 mm and 2000 mm with tension reinforcement of 2614 mm²

Spacing of reinforcement (cl 3.12.11)

Actual distance between bars in tension $s = (b - 2 \times (C_{nom,s} + \phi_v + \phi_{bot}/2)) / (N_{bot} - 1) - \phi_{bot} = \mathbf{141 \text{ mm}}$

Minimum distance between bars in tension (cl 3.12.11.1)

Minimum distance between bars in tension $s_{min} = h_{agg} + 5 \text{ mm} = \mathbf{25 \text{ mm}}$

PASS - Satisfies the minimum spacing criteria

Maximum distance between bars in tension (cl 3.12.11.2)

Design service stress $f_s = (2 \times f_y \times A_{s,req}) / (3 \times A_{s,prov} \times \beta_b) = \mathbf{61.0 \text{ N/mm}^2}$

Maximum distance between bars in tension $s_{max} = \min(47000 \text{ N/mm} / f_s, 300 \text{ mm}) = \mathbf{300 \text{ mm}}$

PASS - Satisfies the maximum spacing criteria

Span to depth ratio (cl. 3.4.6)

Basic span to depth ratio (Table 3.9) $\text{span_to_depth}_{basic} = \mathbf{26.0}$

Design service stress in tension reinforcement $f_s = (2 \times f_y \times A_{s,req}) / (3 \times A_{s,prov} \times \beta_b) = \mathbf{61.0 \text{ N/mm}^2}$

Modification for tension reinforcement

$$f_{tens} = \min(2.0, 0.55 + (477 \text{ N/mm}^2 - f_s) / (120 \times (0.9 \text{ N/mm}^2 + (M / (b \times d^2)))))) = \mathbf{2.000}$$

Modification for compression reinforcement

$$f_{comp} = \min(1.5, 1 + (100 \times A_{s2,prov} / (b \times d)) / (3 + (100 \times A_{s2,prov} / (b \times d)))) = \mathbf{1.130}$$

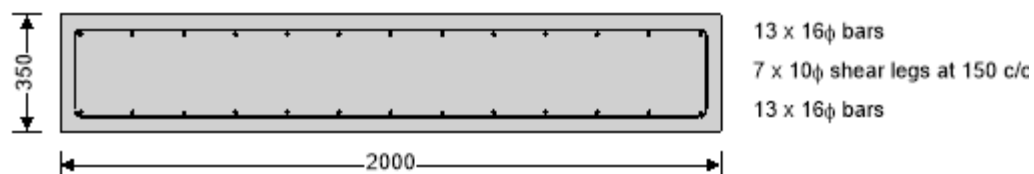
Modification for span length $f_{long} = \mathbf{1.000}$

Allowable span to depth ratio $\text{span_to_depth}_{allow} = \text{span_to_depth}_{basic} \times f_{tens} \times f_{comp} = \mathbf{58.8}$

Actual span to depth ratio $\text{span_to_depth}_{actual} = L_{s4} / d = \mathbf{6.8}$

PASS - Actual span to depth ratio is within the allowable limit

Support E



Design moment resistance of rectangular section (cl. 3.4.4)

Design bending moment $M = \text{abs}(M_{E_red}) = \mathbf{76 \text{ kNm}}$

Depth to tension reinforcement $d = h - C_{nom,t} - \phi_v - \phi_{top} / 2 = \mathbf{292 \text{ mm}}$

Redistribution ratio $\beta_b = \min(1 - m_{rE}, 1) = \mathbf{1.000}$

$$K = M / (b \times d^2 \times f_{cu}) = \mathbf{0.013}$$

$$K' = \mathbf{0.156}$$

K' > K - No compression reinforcement is required

Lever arm $z = \min(d \times (0.5 + (0.25 - K / 0.9)^{0.5}), 0.95 \times d) = \mathbf{277 \text{ mm}}$

Depth of neutral axis $x = (d - z) / 0.45 = \mathbf{32 \text{ mm}}$

Area of tension reinforcement required $A_{s,req} = M / (0.87 \times f_y \times z) = \mathbf{628 \text{ mm}^2}$

Tension reinforcement provided $\mathbf{13 \times 16\phi \text{ bars}}$

Project Kingsley Terrace Aberfan				Job no. 22023	
Calcs for Piled retaining wall base				Start page no./Revision 14 0	
Calcs by EKA	Calcs date 22/05/2023	Checked by SW	Checked date 22/05/2023	Approved by SW	Approved date 22/05/2023

Area of tension reinforcement provided

$$A_{s,prov} = 2614 \text{ mm}^2$$

Minimum area of reinforcement

$$A_{s,min} = 0.0013 \times b \times h = 910 \text{ mm}^2$$

Maximum area of reinforcement

$$A_{s,max} = 0.04 \times b \times h = 28000 \text{ mm}^2$$

PASS - Area of reinforcement provided is greater than area of reinforcement required

Rectangular section in shear

Design shear force span 4 at 1708 mm

$$V = \text{abs}(\min(V_{E_s4_max}, V_{E_s4_red})) = 194 \text{ kN}$$

Design shear stress

$$v = V / (b \times d) = 0.332 \text{ N/mm}^2$$

Design concrete shear stress

$$v_c = 0.79 \times \min(3, [100 \times A_{s,prov} / (b \times d)]^{1/3}) \times \max(1, (400 / d)^{1/4}) \times$$

$$(\min(f_{cu}, 40) / 25)^{1/3} / \gamma_m$$

$$v_c = 0.585 \text{ N/mm}^2$$

Allowable design shear stress

$$v_{max} = \min(0.8 \text{ N/mm}^2 \times (f_{cu} / 1 \text{ N/mm}^2)^{0.5}, 5 \text{ N/mm}^2) = 4.733 \text{ N/mm}^2$$

PASS - Design shear stress is less than maximum allowable

Value of v from Table 3.7

$$0.5 \times v_c < v < (v_c + 0.4 \text{ N/mm}^2)$$

Design shear resistance required

$$v_s = \max(v - v_c, 0.4 \text{ N/mm}^2) = 0.400 \text{ N/mm}^2$$

Area of shear reinforcement required

$$A_{sv,req} = v_s \times b / (0.87 \times f_{yv}) = 1839 \text{ mm}^2/\text{m}$$

Shear reinforcement provided

$$7 \times 10\phi \text{ legs at } 150 \text{ c/c}$$

Area of shear reinforcement provided

$$A_{sv,prov} = 3665 \text{ mm}^2/\text{m}$$

PASS - Area of shear reinforcement provided exceeds minimum required

Maximum longitudinal spacing

$$S_{vl,max} = 0.75 \times d = 219 \text{ mm}$$

PASS - Longitudinal spacing of shear reinforcement provided is less than maximum

Design shear force span 5 at 292 mm

$$V = \max(V_{E_s5_max}, V_{E_s5_red}) = 137 \text{ kN}$$

Design shear stress

$$v = V / (b \times d) = 0.234 \text{ N/mm}^2$$

Design concrete shear stress

$$v_c = 0.79 \times \min(3, [100 \times A_{s,prov} / (b \times d)]^{1/3}) \times \max(1, (400 / d)^{1/4}) \times$$

$$(\min(f_{cu}, 40) / 25)^{1/3} / \gamma_m$$

$$v_c = 0.585 \text{ N/mm}^2$$

Allowable design shear stress

$$v_{max} = \min(0.8 \text{ N/mm}^2 \times (f_{cu} / 1 \text{ N/mm}^2)^{0.5}, 5 \text{ N/mm}^2) = 4.733 \text{ N/mm}^2$$

PASS - Design shear stress is less than maximum allowable

Value of v from Table 3.7

$$v < 0.5v_c$$

Design shear resistance required

$$v_s = \max(v - v_c, 0.4 \text{ N/mm}^2) = 0.400 \text{ N/mm}^2$$

Area of shear reinforcement required

$$A_{sv,req} = v_s \times b / (0.87 \times f_{yv}) = 1839 \text{ mm}^2/\text{m}$$

Shear reinforcement provided

$$7 \times 10\phi \text{ legs at } 150 \text{ c/c}$$

Area of shear reinforcement provided

$$A_{sv,prov} = 3665 \text{ mm}^2/\text{m}$$

PASS - Area of shear reinforcement provided exceeds minimum required

Maximum longitudinal spacing

$$S_{vl,max} = 0.75 \times d = 219 \text{ mm}$$

PASS - Longitudinal spacing of shear reinforcement provided is less than maximum

Spacing of reinforcement (cl 3.12.11)

Actual distance between bars in tension

$$s = (b - 2 \times (C_{nom_s} + \phi_v + \phi_{top}/2)) / (N_{top} - 1) - \phi_{top} = 141 \text{ mm}$$

Minimum distance between bars in tension (cl 3.12.11.1)

Minimum distance between bars in tension

$$s_{min} = h_{agg} + 5 \text{ mm} = 25 \text{ mm}$$

PASS - Satisfies the minimum spacing criteria

Maximum distance between bars in tension (cl 3.12.11.2)

Design service stress

$$f_s = (2 \times f_y \times A_{s,req}) / (3 \times A_{s,prov} \times \beta_b) = 80.1 \text{ N/mm}^2$$

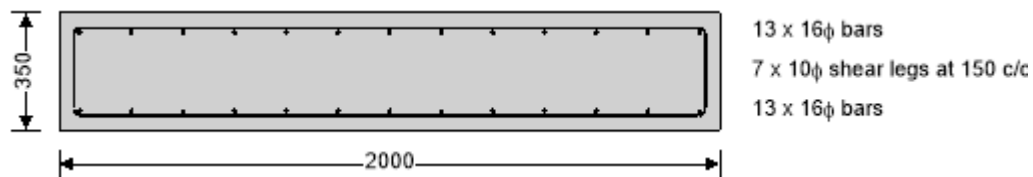
Maximum distance between bars in tension

$$s_{max} = \min(47000 \text{ N/mm} / f_s, 300 \text{ mm}) = 300 \text{ mm}$$

PASS - Satisfies the maximum spacing criteria

Project Kingsley Terrace Aberfan				Job no. 22023	
Calcs for Piled retaining wall base				Start page no./Revision 15 0	
Calcs by EKA	Calcs date 22/05/2023	Checked by SW	Checked date 22/05/2023	Approved by SW	Approved date 22/05/2023

Mid span 5



Design moment resistance of rectangular section (cl. 3.4.4) - Positive moment

Design bending moment $M = \text{abs}(M_{s5_red}) = 9 \text{ kNm}$
 Depth to tension reinforcement $d = h - C_{nom_b} - \phi_v - \phi_{bot} / 2 = 292 \text{ mm}$
 Redistribution ratio $\beta_b = \min(1 - m_{rs5}, 1) = 1.000$
 $K = M / (b \times d^2 \times f_{cu}) = 0.001$
 $K' = 0.156$

$K' > K$ - No compression reinforcement is required

Lever arm $z = \min(d \times (0.5 + (0.25 - K / 0.9)^{0.5}), 0.95 \times d) = 277 \text{ mm}$
 Depth of neutral axis $x = (d - z) / 0.45 = 32 \text{ mm}$
 Area of tension reinforcement required $A_{s,req} = M / (0.87 \times f_y \times z) = 70 \text{ mm}^2$
 Tension reinforcement provided $13 \times 16\phi \text{ bars}$
 Area of tension reinforcement provided $A_{s,prov} = 2614 \text{ mm}^2$
 Minimum area of reinforcement $A_{s,min} = 0.0013 \times b \times h = 910 \text{ mm}^2$
 Maximum area of reinforcement $A_{s,max} = 0.04 \times b \times h = 28000 \text{ mm}^2$

PASS - Area of reinforcement provided is greater than area of reinforcement required

Rectangular section in shear

Shear reinforcement provided $7 \times 10\phi \text{ legs at } 150 \text{ c/c}$
 Area of shear reinforcement provided $A_{sv,prov} = 3665 \text{ mm}^2/\text{m}$
 Minimum area of shear reinforcement (Table 3.7) $A_{sv,min} = 0.4N/\text{mm}^2 \times b / (0.87 \times f_{yv}) = 1839 \text{ mm}^2/\text{m}$

PASS - Area of shear reinforcement provided exceeds minimum required

Maximum longitudinal spacing (cl. 3.4.5.5) $S_{vl,max} = 0.75 \times d = 219 \text{ mm}$

PASS - Longitudinal spacing of shear reinforcement provided is less than maximum

Design concrete shear stress $v_c = 0.79N/\text{mm}^2 \times \min(3, [100 \times A_{s,prov} / (b \times d)]^{1/3}) \times \max(1, (400\text{mm} / d)^{1/4}) \times (\min(f_{cu}, 40N/\text{mm}^2) / 25N/\text{mm}^2)^{1/3} / \gamma_m = 0.585 \text{ N/mm}^2$

Design shear resistance provided $V_{s,prov} = A_{sv,prov} \times 0.87 \times f_{yv} / b = 0.797 \text{ N/mm}^2$

Design shear stress provided $V_{prov} = V_{s,prov} + v_c = 1.382 \text{ N/mm}^2$

Design shear resistance $V_{prov} = V_{prov} \times (b \times d) = 807.2 \text{ kN}$

Shear links provided valid between 0 mm and 1000 mm with tension reinforcement of 2614 mm²

Spacing of reinforcement (cl 3.12.11)

Actual distance between bars in tension $s = (b - 2 \times (C_{nom_s} + \phi_v + \phi_{bot}/2)) / (N_{bot} - 1) - \phi_{bot} = 141 \text{ mm}$

Minimum distance between bars in tension (cl 3.12.11.1)

Minimum distance between bars in tension $S_{min} = h_{agg} + 5 \text{ mm} = 25 \text{ mm}$

PASS - Satisfies the minimum spacing criteria

Maximum distance between bars in tension (cl 3.12.11.2)

Design service stress $f_s = (2 \times f_y \times A_{s,req}) / (3 \times A_{s,prov} \times \beta_b) = 9.0 \text{ N/mm}^2$

Maximum distance between bars in tension $S_{max} = \min(47000 \text{ N/mm} / f_s, 300 \text{ mm}) = 300 \text{ mm}$

PASS - Satisfies the maximum spacing criteria

Project Kingsley Terrace Aberfan				Job no. 22023	
Calcs for Piled retaining wall base				Start page no./Revision 16 0	
Calcs by EKA	Calcs date 22/05/2023	Checked by SW	Checked date 22/05/2023	Approved by SW	Approved date 22/05/2023

Span to depth ratio (cl. 3.4.6)

Basic span to depth ratio (Table 3.9)

$$\text{span_to_depth}_{\text{basic}} = \mathbf{26.0}$$

Design service stress in tension reinforcement

$$f_s = (2 \times f_y \times A_{s,\text{req}}) / (3 \times A_{s,\text{prov}} \times \beta_b) = \mathbf{9.0 \text{ N/mm}^2}$$

Modification for tension reinforcement

$$f_{\text{tens}} = \min(2.0, 0.55 + (477 \text{ N/mm}^2 - f_s) / (120 \times (0.9 \text{ N/mm}^2 + (M / (b \times d^2)))))) = \mathbf{2.000}$$

Modification for compression reinforcement

$$f_{\text{comp}} = \min(1.5, 1 + (100 \times A_{s2,\text{prov}} / (b \times d)) / (3 + (100 \times A_{s2,\text{prov}} / (b \times d)))) = \mathbf{1.130}$$

Modification for span length

$$f_{\text{long}} = 1.000$$

Allowable span to depth ratio

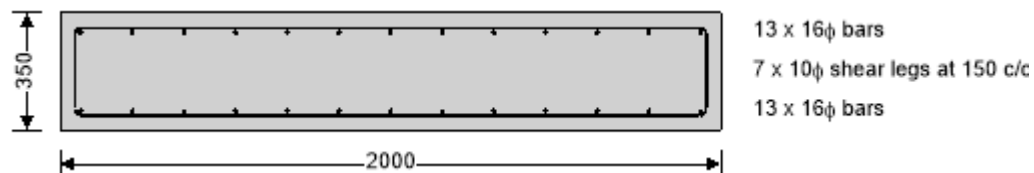
$$\text{span_to_depth}_{\text{allow}} = \text{span_to_depth}_{\text{basic}} \times f_{\text{tens}} \times f_{\text{comp}} = \mathbf{58.8}$$

Actual span to depth ratio

$$\text{span_to_depth}_{\text{actual}} = L_{s5} / d = \mathbf{3.4}$$

PASS - Actual span to depth ratio is within the allowable limit

Support F



Rectangular section in shear

Design shear force span 5 at 708 mm

$$V = \max(V_{F_{s5_max}}, V_{F_{s5_red}}) = \mathbf{15 \text{ kN}}$$

Design shear stress

$$v = V / (b \times d) = \mathbf{0.026 \text{ N/mm}^2}$$

Design concrete shear stress

$$v_c = 0.79 \times \min(3, [100 \times A_{s,\text{prov}} / (b \times d)]^{1/3}) \times \max(1, (400 / d)^{1/4}) \times$$

$$(\min(f_{cu}, 40) / 25)^{1/3} / \gamma_m$$

$$v_c = \mathbf{0.585 \text{ N/mm}^2}$$

Allowable design shear stress

$$v_{\text{max}} = \min(0.8 \text{ N/mm}^2 \times (f_{cu} / 1 \text{ N/mm}^2)^{0.5}, 5 \text{ N/mm}^2) = \mathbf{4.733 \text{ N/mm}^2}$$

PASS - Design shear stress is less than maximum allowable

Value of v from Table 3.7

$$v < 0.5v_c$$

Design shear resistance required

$$v_s = \max(v - v_c, 0.4 \text{ N/mm}^2) = \mathbf{0.400 \text{ N/mm}^2}$$

Area of shear reinforcement required

$$A_{sv,\text{req}} = v_s \times b / (0.87 \times f_{yv}) = \mathbf{1839 \text{ mm}^2/\text{m}}$$

Shear reinforcement provided

$$7 \times 10\phi \text{ legs at } 150 \text{ c/c}$$

Area of shear reinforcement provided

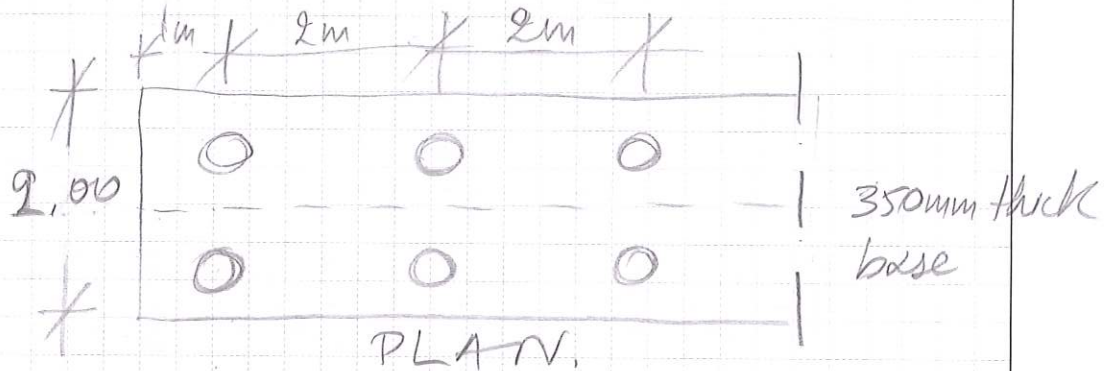
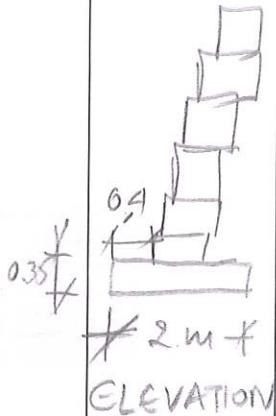
$$A_{sv,\text{prov}} = \mathbf{3665 \text{ mm}^2/\text{m}}$$

PASS - Area of shear reinforcement provided exceeds minimum required

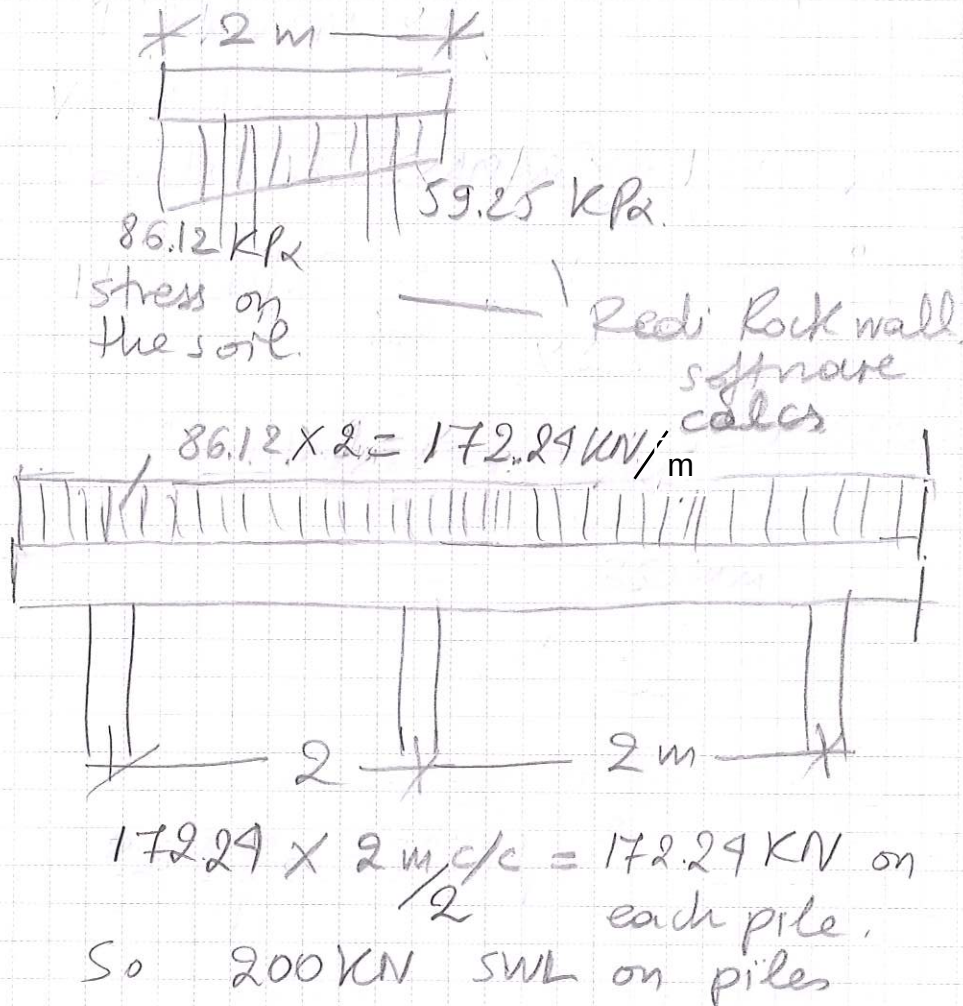
Maximum longitudinal spacing

$$S_{vl,\text{max}} = 0.75 \times d = \mathbf{219 \text{ mm}}$$

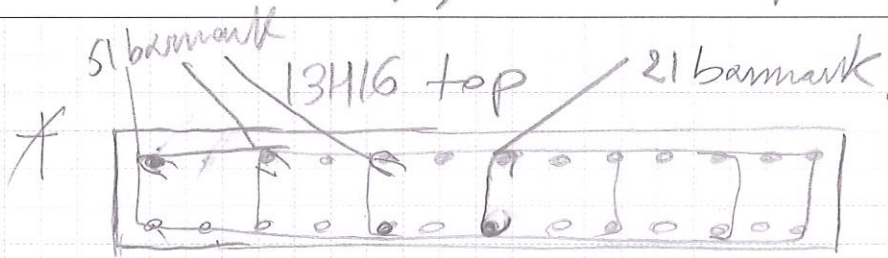
PASS - Longitudinal spacing of shear reinforcement provided is less than maximum



Piles 20-250mm 200KN SWL founded into the underlying competent sandstone bedrock.



Project <i>Kingsley Terrace Aberfa</i>		Job Ref. <i>22023</i>	
Section <i>Design of rebar</i>		Sheet no./rev. <i>02</i>	
Calc. by <i>EKA</i>	Date <i>22/05/23</i>	Chk'd by <i>SW</i>	Date <i>22/05/23</i>
		App'd by <i>SW</i>	Date <i>22/05/23</i>



13H16 bottom

LINK H10 @ 150c/c

I legs.