

Job Title: Trebanos	Job number: 275375-50
Filing location: \\global\europa\Cardiff\Jobs\275000\275281-00\4 Internal Project Data\4-40 Calculations\Structural	
Calc Title: Trebanos Kingpost Headwall	

Project Stage: Detailed Design	Revision: No Revision	Date: 10/05/2024																								
Made by: Tingyi Yan	Signature:																									
<u>Introduction</u> The Works comprise the construction of a King Post retaining wall as a stormwater outfall headwall. The wall will be formed from augured piles with plunged steel sections with precast reinforced concrete planks and cast in situ collar panel around the outfall pipe. Piling techniques are anticipated to comprise CFA or Cased CFA. Open bored piles are unlikely to be suitable due to the requirement to use casings to full depth. For dimension details please see B16421-102503-01-ZZ-DR-CA-CI5051. <u>Design Assumptions (refer to calculation plan)</u> Concrete grade: C28/35 for concrete planking, piling and slab. Gen 3 for mass concrete infill Nominal cover: 50mm if in contact with blinding. 45mm if in contact with formwork only. Design method: Concrete planking is designed as simply supported beam, bending moment capacity is checked. Capacity of steel section is checked. Mass concrete infill pour section capacity is checked considering it's cantilevering between the edge of the planking and the top edge of the pipe. Design life: A Standard structural design life of "in excess of 50 years" has been adopted. <u>Model Reference</u> N.A CDM issues associated with the design? N.A Are there any construction sequence issues associated with the design? Have these been communicated to the Contractor? (i.e hangers, top down construction, design loadings, propped walls etc.)																										
Design Check List <i>Reference should be made to the Arup 'Good Practice Guide to Calculations' for preparing calculations.</i> <table border="1"> <tr> <td>Checking Engineer: Nick Jones</td> <td>Signature:</td> <td>Date: 17/05/2024</td> </tr> <tr> <td>Is 3D or FE computer analysis required? <i>If yes agree extent with design team leader.</i></td> <td colspan="2">N.A</td> </tr> <tr> <td>Has a hand calculation check been carried out to verify the computer model?</td> <td colspan="2">N.A</td> </tr> <tr> <td>Checking – refer to the project checking plan for scope. (All calculations should be self checked before issuing for checking)</td> <td colspan="2"> Checking Level (tick) <table border="1"> <tr> <td>Numbers</td> <td></td> <td>Principle</td> <td></td> <td>Independent (Third Party)</td> <td></td> </tr> </table> </td> </tr> <tr> <td>Explain why the selected checking level is appropriate.</td> <td colspan="2">Relatively low risk of structural overload and low consequences from failure, simple principles</td> </tr> <tr> <td>Mention why the selected checking</td> <td colspan="2">Engineer is experienced general civil/structural engineer</td> </tr> </table>			Checking Engineer: Nick Jones	Signature:	Date: 17/05/2024	Is 3D or FE computer analysis required? <i>If yes agree extent with design team leader.</i>	N.A		Has a hand calculation check been carried out to verify the computer model?	N.A		Checking – refer to the project checking plan for scope. (All calculations should be self checked before issuing for checking)	Checking Level (tick) <table border="1"> <tr> <td>Numbers</td> <td></td> <td>Principle</td> <td></td> <td>Independent (Third Party)</td> <td></td> </tr> </table>		Numbers		Principle		Independent (Third Party)		Explain why the selected checking level is appropriate.	Relatively low risk of structural overload and low consequences from failure, simple principles		Mention why the selected checking	Engineer is experienced general civil/structural engineer	
Checking Engineer: Nick Jones	Signature:	Date: 17/05/2024																								
Is 3D or FE computer analysis required? <i>If yes agree extent with design team leader.</i>	N.A																									
Has a hand calculation check been carried out to verify the computer model?	N.A																									
Checking – refer to the project checking plan for scope. (All calculations should be self checked before issuing for checking)	Checking Level (tick) <table border="1"> <tr> <td>Numbers</td> <td></td> <td>Principle</td> <td></td> <td>Independent (Third Party)</td> <td></td> </tr> </table>		Numbers		Principle		Independent (Third Party)																			
Numbers		Principle		Independent (Third Party)																						
Explain why the selected checking level is appropriate.	Relatively low risk of structural overload and low consequences from failure, simple principles																									
Mention why the selected checking	Engineer is experienced general civil/structural engineer																									

Job Title: Trebanos	Job number: 275375-50
Filing location: \\global\europa\Cardiff\Jobs\275000\275281-00\4 Internal Project Data\4-40 Calculations\Structural	
Calc Title: Trebanos Kingpost Headwall	

engineer is appropriate to perform the check.			
Calculations to be issued externally?		No	
Issue Date:			
Revision: 00	Project Stage: Detailed Design	Date:	
Made by: Tingyi		Signature:	
Description of Revision (Brief description of the calculations including reference to location)			
Cause of Revision (Internal check or company name or discipline)			
Impact of revision (Including a list of any other calculations or reports which might be affected by this revision)			
Have all other potentially affected calculations or reports been completely updated? (Y/N) (List revised calculations/ report including new revision)			
Revised Model Reference (file name and revision)			
Checking – refer to the project checking plan for scope. (All calculations should be self checked before issuing for checking)		Checking Level (tick)	
		Numbers ☐	Principle ☐
Explain why the selected checking level is appropriate.			
Mention why the selected checking engineer is appropriate to perform the check.			
Calculations to be issued externally?			
Issue Date:			

A 3D architectural rendering of a modern building. The building features a glass facade and a central staircase with a metal railing. The building is surrounded by stacks of stone blocks, suggesting a construction or storage area. The rendering is in a wireframe style, showing the structural elements of the building and the stacks of blocks.

Pile spacing	Minimum toe level for stability	Action effect in pile (DA1C1 factored)	
		Shear force	Bending moment
1.5	+16	60 kN/pile	150 kNm/pile
2.0	+15.5	80 kN/pile	210 kNm/pile
2.5	+15.0	100 kN/pile	280 kNm/pile
3.0	+14.0	120 kN/pile	360 kNm/pile

[illegible]

Structural analysis of planking

2m span planking

$$\frac{20 \text{ kPa} \cdot (2 \text{ m})^2}{8} = 10 \text{ kN} \cdot \frac{\text{m}}{\text{m}}$$

Input for concrete compute for 2m span planking RC design

$$\frac{20 \text{ kPa} \cdot 2 \text{ m}}{2} = 20 \frac{\text{kN}}{\text{m}}$$

To compare with Shear capacity calculated from Arup Compute

$$\left(\frac{10 \text{ mm}}{2} \right)^2 \cdot \pi \cdot \frac{1000}{200 \text{ m}} = 392.699 \frac{\text{mm}^2}{\text{m}}$$

area of steel reinforcement provided as it's 2No. of B10 bar in one 200mm depth plank

3m span planking

$$\frac{20 \text{ kPa} \cdot (3 \text{ m})^2}{8} = 22.5 \text{ kN} \cdot \frac{\text{m}}{\text{m}}$$

Input for concrete compute for 3m span planking RC design

$$\frac{20 \text{ kPa} \cdot 3 \text{ m}}{2} = 30 \frac{\text{kN}}{\text{m}}$$

To compare with Shear capacity calculated from Arup Compute

$$2 \left(\frac{10 \text{ mm}}{2} \right)^2 \cdot \pi \cdot \frac{1000}{200 \text{ m}} = 785.398 \frac{\text{mm}^2}{\text{m}}$$

area of steel reinforcement provided as it's 4No. of B10 bar in one 200mm depth plank

Anchorage Length of steel reinforcement in concrete planking & rebar dimensions

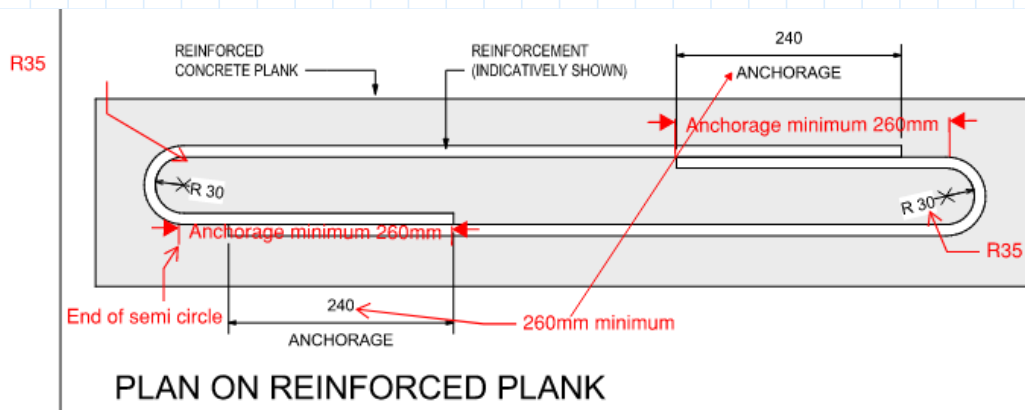


Table 2 — Minimum scheduling radii, former diameters and bend allowances

Nominal size of bar, d	Minimum radius for scheduling, r	Minimum diameter of bending former, M	Minimum end projection, P	
mm	mm	mm	General (min $5d$ straight), including links where bend $\geq 150^\circ$	Links where bend $< 150^\circ$ (min $10d$ straight)
			mm	mm
6	12	24	110 ^a	110 ^a
8	16	32	115 ^a	115 ^a
10	20	40	120 ^a	130
12	24	48	125 ^a	160
16	32	64	130	210
20	70	140	190	290
25	87	175	240	365
32	112	224	305	465
40	140	280	380	580
50	175	350	475	725

^a The minimum end projections for smaller bars is governed by the practicalities of bending bars.

NOTE 1 Due to "spring back" the actual radius of bend will be slightly greater than half the diameter of former.

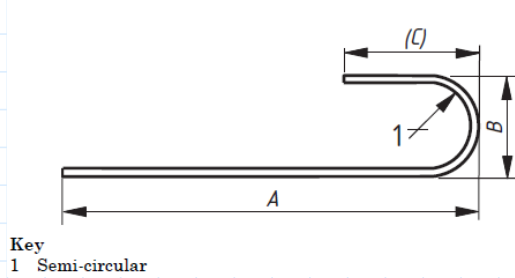
NOTE 2 BS 4449:2005 grade B500A in sizes below 8 mm does not conform to BS EN 1992-1-1:2004.

Bar Diameter

$\phi := 10 \text{ mm}$

Bar radius

$r.10 := 35 \text{ mm}$



$$A + 0.57B + (C) - 1.6d$$

B shall not be less than $2(r + d)$.
Neither A nor C shall be less than P
in Table 2 nor less than $(B/2 + 5d)$.
See Note 3.

A - make it longer than the longest anticipated plank and to be cut to suit on site.

$$B.10 := 2 \cdot (r.10 + \phi)$$

$$B.10 = 90 \text{ mm}$$

Nominal cover $cover.plank := 45 \text{ mm}$

$$B.10 + 2 \cdot cover.plank + \phi = 190 \text{ mm} < 200 \text{ mm hence ok}$$

3.12.9.4 Anchorage of bars at a simply-supported end of a member

At a simply-supported end of a member, each tension bar should be anchored by one of the following:

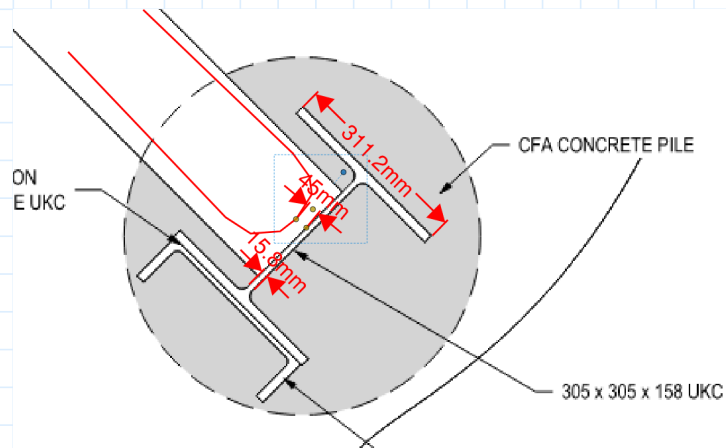
- an effective anchorage length equivalent to 12 times the bar size beyond the centre-line of the support; no bend or hook should begin before the centre of the support;
- an effective anchorage length equivalent to 12 times the bar size plus $d/2$ from the face of the support, where d is the effective depth of member; no bend or hook should begin before $d/2$ from the face of the support;
- for slabs, if the design ultimate shear stress at the face of the support is less than half the appropriate value, v_c , recommended in 3.4.5, a straight length of bar beyond the centre-line of the support equal to either one-third of the support width or 30 mm, whichever is the greater.

Depth of planking $d.p := 200 \text{ mm}$

Anchorage length from face of support

$$l.bd := 12 \cdot \phi + \frac{\left(d.p - cover.plank - \frac{\phi}{2}\right)}{2}$$

$$l.bd = 195 \text{ mm}$$



Distance between end of semi-circle of hook and the face of support

$$d.sf := \frac{311.2 \text{ mm} - 15.8 \text{ mm}}{2} - \text{cover.plank} - \phi - r.10$$

$$d.sf = 57.7 \text{ mm}$$

Anchorage length $l.a.bd := d.sf + l.bd$

$$l.a.bd = 252.7 \text{ mm}$$

round it to 260mm

$$C.10 := 260 \text{ mm} + r.10 + \phi$$

$$C.10 = 0.305 \text{ m}$$

BENDING SCHEDULE FOR 3M SPAN CONCRETE PLANK. DIMENSION A IS CUT TO SUITE SITE.

Location	Bar mark	Type and size		Number of members	Number in each	Total number	Length of each bar mm	Shape code	All bending dimensions are in accordance with BS 8666					REV
									A	B	C	D	E/R	
		type	Ø mm						mm	mm	mm	mm	mm	
Concrete plank	13	B	10	1	4	4	3350	13	3000	90	305			

Capacity check for Piling

Checking capacity for UKC 305x305x97 (S355)

The length between lateral restraint is the length above the slab. In this case it's 3m.

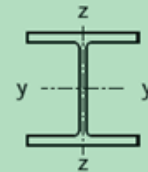
Steel building design: Design data - "Blue Book" (P363)

BS EN 1993-1-1:2005
BS 4-1:2005

BENDING

S355 / Advance® 355

UNIVERSAL COLUMNS Advance® UKC



Designation	Cross section resistance (kNm)	Classification	$C_1^{(1)}$	Buckling Resistance Moment $M_{b,Rd}$ (kNm) for Length between lateral restraints (m)													Second Moment of Area y-y axis I_y cm ⁴
				2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	
305x305x137	$M_{c,y,Rd} = 792$ $M_{c,z,Rd} = 363$	Class = 1	1.00	792	783	746	709	673	637	603	570	539	510	484	459	436	32800
			1.13	792	792	776	743	711	679	647	615	585	557	529	504	480	
			1.35	792	792	792	790	763	736	708	681	653	626	599	574	550	
			1.50	792	792	792	792	792	768	743	718	692	667	642	617	593	
			1.77	792	792	792	792	792	792	792	773	752	729	707	684	662	
			2.00	792	792	792	792	792	792	792	792	792	792	773	753	733	
305x305x118	$M_{c,y,Rd} = 675$ $M_{c,z,Rd} = 309$	Class = 1	2.50	792	792	792	792	792	792	792	792	792	792	792	792	792	27700
			1.00	675	665	630	596	562	528	495	464	435	408	384	362	342	
			1.13	675	675	657	626	595	564	533	503	474	447	422	399	377	
			1.35	675	675	675	667	642	615	588	560	533	507	482	458	435	
			1.50	675	675	675	675	667	644	619	593	568	543	519	495	472	
			1.77	675	675	675	675	675	675	665	643	621	599	576	554	533	
305x305x97	$M_{c,y,Rd} = 513$ $M_{c,z,Rd} = 170$	Class = 3	2.00	675	675	675	675	675	675	675	675	658	639	618	598	577	22200
			2.50	675	675	675	675	675	675	675	675	675	675	675	675	675	
			1.00	513	506	479	451	423	395	367	342	318	296	277	260	244	
			1.13	513	513	499	474	449	423	397	371	348	325	305	286	269	
			1.35	513	513	513	506	485	462	439	416	393	371	350	330	312	
			1.50	513	513	513	513	505	484	463	442	420	399	378	358	340	
305x305x97	$M_{c,y,Rd} = 513$ $M_{c,z,Rd} = 170$	Class = 3	1.77	513	513	513	513	513	513	499	481	462	442	423	404	386	22200
			2.00	513	513	513	513	513	513	513	508	491	474	456	438	421	
			2.50	513	513	513	513	513	513	513	513	513	513	512	498	483	

Advance® and UKC are trademarks of Tata Steel. A fuller description of the relationship between Universal Columns (UC) and the Advance® range of sections manufactured by Tata Steel is given in note 12.

⁽¹⁾ C_1 is the factor dependent on the loading and end restraints; see note 8.

Section classification given applies to members subject to bending about the y-y axis only.

FOR EXPLANATION OF TABLES SEE NOTE 8.

C_1 value is 1.77 as it is a cantilever above ground.

The C_1 values of 1.13, 1.35 and 1.77 correspond to common design situations, as shown below.

Loading	Bending moment diagram	C_1 factor
UDL, pin-ended beam		1.13
Central point load, pin-ended beam		1.35
Triangular bending moment diagram, pin at one end		1.77

Capacity of 513kN*m is bigger than the design moment of 3m spacing piles which is 360kN*m. Thus UKC 305x305x97 (S355) is satisfactory.

Checking Shear Capacity - Capacity of 721kN is bigger than the design moment of 120kN. Thus UKC 305x305x97 (S355) is satisfactory.

BS EN 1993-1-5: 2007
BS 4-1: 2005

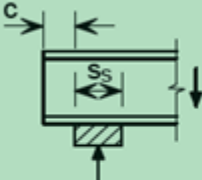
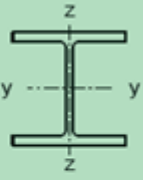
WEB BEARING AND BUCKLING

UNIVERSAL COLUMNS

Advance® UKC

Unstiffened webs

S355 / Advance® 355

Section Designation	Design Shear Resistance $V_{c,Rd}$ kN	Position of Stiff Bearing F_{Rd} (c = 0) c_{lim} (mm) F_{Rd} (c ≥ c_{lim})	Design resistance of unstiffened web, F_{Rd} (kN) and limiting length, c_{lim} (mm)												
			Stiff bearing length, s_b (mm)												
			0	10	20	30	40	50	75	100	150	200	250	300	350
305x305x283	1950	F_{Rd} (c = 0) c_{lim} (mm) F_{Rd} (c ≥ c_{lim})	971 250 3540	1070 250 3630	1170 250 3720	1280 250 3810	1390 250 3900	1520 250 3990	1860 250 4210	2220 250 4440	2720 250 4880	3170 250 5330	3620 250 5780	4070 250 6230	4520 250 6680
305x305x240	1710	F_{Rd} (c = 0) c_{lim} (mm) F_{Rd} (c ≥ c_{lim})	787 220 2820	870 220 2900	962 220 2980	1060 220 3060	1170 220 3140	1280 220 3220	1580 220 3420	1910 220 3620	2300 220 4020	2700 220 4410	3100 220 4810	3490 220 5210	3890 220 5600
305x305x198	1400	F_{Rd} (c = 0) c_{lim} (mm) F_{Rd} (c ≥ c_{lim})	594 200 2090	663 200 2160	740 200 2230	823 200 2290	913 200 2360	1010 200 2420	1270 200 2590	1500 200 2750	1830 200 3080	2160 200 3410	2490 200 3740	2820 200 4070	3150 200 4400
305x305x158	1130	F_{Rd} (c = 0) c_{lim} (mm) F_{Rd} (c ≥ c_{lim})	428 190 1480	486 180 1540	550 170 1590	621 170 1650	698 170 1700	780 170 1760	1000 170 1890	1150 170 2030	1420 170 2300	1700 170 2570	1970 170 2850	2240 170 3120	2510 170 3390
305x305x137	984	F_{Rd} (c = 0) c_{lim} (mm) F_{Rd} (c ≥ c_{lim})	346 190 1190	397 180 1230	454 170 1280	517 160 1330	585 150 1380	658 150 1420	846 150 1540	965 150 1660	1200 150 1900	1440 150 2140	1680 150 2380	1920 150 2610	2160 150 2790
305x305x118	856	F_{Rd} (c = 0) c_{lim} (mm) F_{Rd} (c ≥ c_{lim})	277 190 939	322 180 980	372 170 1020	428 160 1060	488 150 1100	553 140 1150	702 140 1250	806 140 1350	1010 140 1560	1220 140 1780	1430 140 1980	1630 140 2180	1820 140 2380
305x305x97	721	F_{Rd} (c = 0) c_{lim} (mm) F_{Rd} (c ≥ c_{lim})	213 190 709	251 180 745	294 170 780	343 160 815	395 150 850	451 140 885	564 120 998	652 120 1040	828 120 1120	1010 130 1210	1100 130 1280	1170 130 1350	1250 130 1410

To account for durability, assuming one face of the i column is in contact with soil and the other side in contact with sewerage water. Design life is 100 years. Then the total steel loss is 5.5mm.

Table 4-1: Recommended value for the loss of thickness [mm] due to corrosion for piles and sheet piles in soils, with or without groundwater

Required design working life	5 years	25 years	50 years	75 years	100 years
Undisturbed natural soils (sand, silt, clay, schist,)	0,00	0,30	0,60	0,90	1,20
Polluted natural soils and industrial sites	0,15	0,75	1,50	2,25	3,00
Aggressive natural soils (swamp, marsh, peat, ...)	0,20	1,00	1,75	2,50	3,25
Non-compacted and non-aggressive fills (clay, schist, sand, silt,)	0,18	0,70	1,20	1,70	2,20
Non-compacted and aggressive fills (ashes, slag,)	0,50	2,00	3,25	4,50	5,75
Notes: 1) Corrosion rates in compacted fills are lower than those in non-compacted ones. In compacted fills the figures in the table should be divided by two. 2) The values given for 5 and 25 years are based on measurements, whereas the other values are extrapolated.					

Ref: EC3 part 5 - piling

Table 4-2: Recommended value for the loss of thickness [mm] due to corrosion for piles and sheet piles in fresh water or in sea water

Required design working life	5 years	25 years	50 years	75 years	100 years
Common fresh water (river, ship canal,) in the zone of high attack (water line)	0,15	0,55	0,90	1,15	1,40
Very polluted fresh water (sewage, industrial effluent,) in the zone of high attack (water line)	0,30	1,30	2,30	3,30	4,30
Sea water in temperate climate in the zone of high attack (low water and splash zones)	0,55	1,90	3,75	5,60	7,50
Sea water in temperate climate in the zone of permanent immersion or in the intertidal zone	0,25	0,90	1,75	2,60	3,50
Notes: 1) The highest corrosion rate is usually found in the splash zone or at the low water level in tidal waters. However, in most cases, the highest bending stresses occur in the permanent immersion zone, see Figure 4-1. 2) The values given for 5 and 25 years are based on measurements, whereas the other values are extrapolated.					

Ref: EC3 part 5 - piling

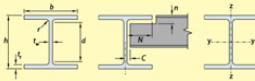
305X305X97 web thickness is 9.9mm, then we need web thickness of at least 15.4mm so size it up to 305x305x158 which gives 15.8mm.

EUROCODE 3 (IN ACCORDANCE WITH THE UK NATIONAL ANNEX) | BS EN 10380:2017

Universal columns (UC) ▾ Section properties ▾

Print design data Export to excel

Dimensions & properties



Section designation	Mass per metre kg/m	Depth of section h mm	Width of section b mm	Thickness		Root radius r mm	Dimensions		Ratios for local buckling		End clearance C mm	Dimensions for detailing			Surface area		Second moment of area	
				Web t _w mm	Flange t _f mm		Depth between fillets d mm	Web c _w / t _w	Flange c _f / t _f	N mm		n mm	Per metre m ²	Per tonne m ²	Axis y-y cm ⁴	Axis z-z cm ⁴		
x 129	129.0	355.6	368.6	10.4	17.5	15.2	290.2	27.9	9.37	7	190	34	2.14	16.6	40200	1460		
305 x 305 x 283	282.9	365.3	322.2	26.8	44.1	15.2	246.7	9.21	3.00	15	158	60	1.54	6.86	78900	2460		
x 240	240.0	352.5	318.4	23.0	37.7	15.2	246.7	10.7	3.51	14	158	54	1.91	7.96	64200	2030		
x 198	198.1	339.9	314.5	19.1	31.4	15.2	246.7	12.9	4.22	12	158	48	1.87	9.44	50900	1630		
x 158	158.1	327.1	311.2	15.8	25.0	15.2	246.7	15.6	5.30	10	158	42	1.84	11.6	38700	1260		
x 137	136.9	320.5	309.2	13.8	21.7	15.2	246.7	17.9	6.11	9	158	38	1.82	13.3	32800	1070		
x 118	117.9	314.5	307.4	12.0	18.7	15.2	246.7	20.6	7.09	8	158	34	1.81	15.4	27700	966		
x 97	96.9	307.9	305.3	9.9	15.4	15.2	246.7	24.9	8.60	7	158	32	1.79	18.5	22200	731		
254 x 254 x 167	167.1	289.1	265.2	19.2	31.7	12.7	200.3	10.4	3.48	12	134	46	1.58	9.46	30000	987		
x 132	132.0	276.3	261.3	15.3	25.3	12.7	200.3	13.1	4.36	10	134	38	1.55	11.7	22500	753		
x 107	107.1	266.7	258.8	12.8	20.5	12.7	200.3	15.6	5.38	8	134	34	1.52	14.2	17500	593		
x 89	88.9	260.3	256.3	10.3	17.3	12.7	200.3	19.4	6.38	7	134	30	1.50	16.9	14300	469		
x 73	73.1	254.1	254.6	8.6	14.2	12.7	200.3	23.3	7.77	6	134	28	1.49	20.4	11400	391		
203 x 203 x 127 +	127.5	241.4	213.9	18.1	30.1	10.2	160.8	8.88	2.91	11	108	42	1.28	10.0	15400	492		
x 113 +	113.5	235.0	212.1	16.3	26.9	10.2	160.8	9.87	3.26	10	108	38	1.27	11.2	13300	429		
x 100 +	99.6	228.6	210.3	14.5	23.7	10.2	160.8	11.1	3.70	9	108	34	1.25	12.6	11300	368		
x 86	86.1	222.2	209.1	12.7	20.5	10.2	160.8	12.7	4.29	8	110	32	1.24	14.4	9450	313		
x 71	71.0	215.8	206.4	10.0	17.3	10.2	160.8	16.1	5.09	7	110	28	1.22	17.2	7620	254		
x 60	60.0	209.6	205.8	9.4	14.2	10.2	160.8	17.1	6.20	7	110	26	1.21	20.2	6120	206		
x 52	52.0	206.2	204.3	7.9	12.5	10.2	160.8	20.4	7.04	6	110	24	1.20	23.1	5260	178		
x 46	46.1	203.2	203.6	7.2	11.0	10.2	160.8	22.3	8.00	6	110	22	1.19	25.8	4570	155		
2 x 152 x 51 +	51.2	170.2	157.4	11.0	15.7	7.6	123.6	11.2	4.18	8	84	24	0.935	18.3	3230	102		
x 44 +	44.0	166.0	155.9	9.5	13.6	7.6	123.6	13.0	4.82	7	84	22	0.924	21.0	2700	86		

Thus provide I column - UC 305x305x158

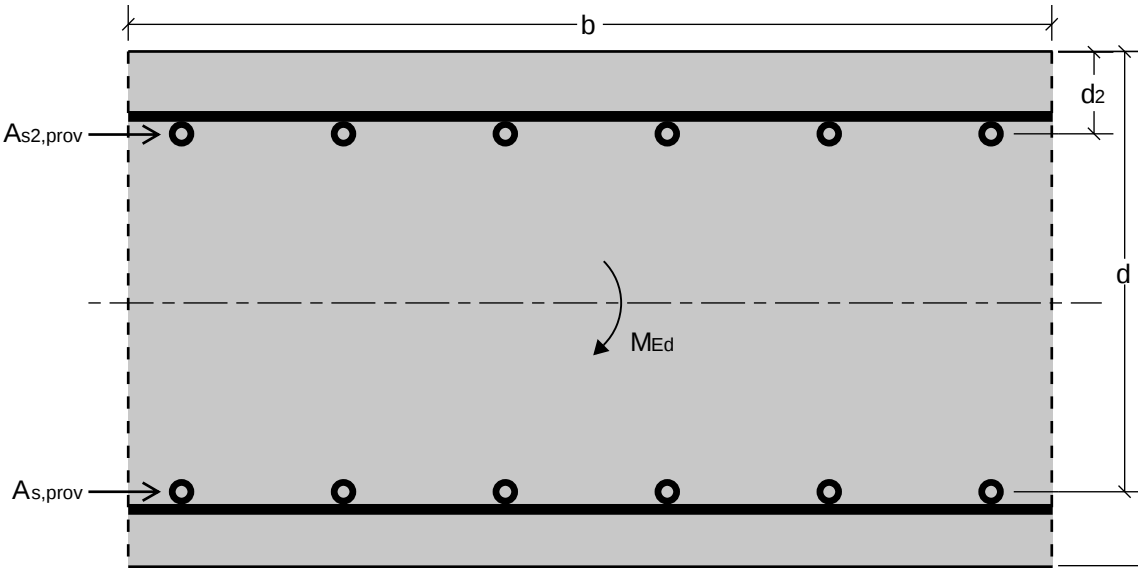
Calculation sheet	Job No.		Rev.
	275375-50		2
	Member Location3m span concrete plank		
Job TitleTrebanos Headwall	Drg. ref. B16241-102503-01-ZZ-DR-CA-CI5052_C03		
	Made ByTY	Date10-05-2024	Chd. NJ

Area of tension and compression steel required in section subject to bending

Calculates the area of steel required in an RC section to resist a given moment. Implements the equations given in 'How to design concrete structures using Eurocode 2' (The Concrete Centre, 2011), Section 4, Figure 2..

Calculation ID: 1000

Remark: This calculation will only accept a positive value for the applied momemnt and acts in the direction shown below.



Definition of inputs.

Inputs

Overall width of a cross-section, or actual flange width in a T or L beam	$b = 1 \times 10^3 \text{ mm}$
Overall depth of a cross-section	$h = 200 \text{ mm}$
Effective depth of a cross-section	$d = 140 \text{ mm}$
Distance from face in compression to centre of compression reinforcement	$d_2 = 50 \text{ mm}$
Characteristic compressive cylinder strength of concrete at 28 days	$f_{ck} = 28 \text{ N/mm}^2$
Characteristic yield strength of reinforcement	$f_{yk} = 500 \text{ N/mm}^2$
Partial factor for reinforcing or pre-stressing steel	$\gamma_S = 1.15$
Design value of the applied internal bending moment	$M_{Ed} = 22.5 \text{ kNm}$
Cross-sectional area of reinforcement provided	$A_{s,prov} = 785 \text{ mm}^2$
Area of compression steel provided	$A_{s2,prov} = 785 \text{ mm}^2$

Calculation

Calculation sheet	Job No.		Rev.
	275375-50		2
	Member Location3m span concrete plank		
Job TitleTrebanos Headwall	Drg. ref. B16241-102503-01-ZZ-DR-CA-CI5052_C03		
	Made ByTY	Date10-05-2024	Chd. NJ

K factor

$$K = \frac{|M_{Ed}| \times 10^6}{b \times d^2 \times f_{ck}}$$
$$= \frac{|22.5 \text{ kNm}| \times 10^6}{1 \times 10^3 \text{ mm} \times (140 \text{ mm})^2 \times 28 \text{ N/mm}^2}$$
$$= 0.041$$

Maximum value of K before
compression reinforcement is required

$K' = 0.168$

K <= K' so compression steel is not utilised

Area of compressive steel required

$A_{s2, req} = 0 \text{ mm}^2$

Lever arm of internal forces

$$z = \frac{d}{2} \times \left(1 + \sqrt{1 - 3.53 \times K}\right)$$
$$= \frac{140 \text{ mm}}{2} \times \left(1 + \sqrt{1 - 3.53 \times 0.041}\right)$$
$$= 135 \text{ mm}$$

Lever arm of internal forces

$$z = \min(z, 0.95 \times d)$$
$$= \min(135 \text{ mm}, 0.95 \times 140 \text{ mm})$$
$$= 133 \text{ mm}$$

Required area of steel

Design strength of reinforcing steel

Calculate the design (factored) strength of reinforcing steel using the Eurocode partial factor method

EC0 6.3.3 (1)

Design yield strength of reinforcement

$$f_{yd} = \frac{f_{yk}}{\gamma_S}$$
$$= \frac{500 \text{ N/mm}^2}{1.15}$$
$$= 435 \text{ N/mm}^2$$

See Also BS EN 1992-1-1 Table (2.1) for recommended values of gamma_S

$f_{yd} = 435 \text{ N/mm}^2$

Area of longitudinal reinforcement
required

$$A_{sl, req} = \frac{|M_{Ed}| \times 10^6}{z \times f_{yd}}$$
$$= \frac{|22.5 \text{ kNm}| \times 10^6}{133 \text{ mm} \times 435 \text{ N/mm}^2}$$
$$= 389 \text{ mm}^2$$

Limiting areas of steel

Expression (9.1N)

Calculating the minimum allowable area of steel

ARUP Calculation sheet		Job No.	Rev.
		275375-50	2
		Member Location3m span concrete plank	
Job Title	Trebanos Headwall	Drg. ref. B16241-102503-01-ZZ-DR-CA-CI5052_C03	
		Made ByTY	Date10-05-2024Chd.NJ
EC2-1-1 (9.1N)	Minimum cross sectional area of reinforcement	$A_{s,min} = \max \left(0.26 \times \frac{f_{ctm}}{f_{yk}} \times b_t \times d, 0.0013 \times b_t \times d \right)$$= \max \left(0.26 \times \frac{2.77 \text{ N/mm}^2}{500 \text{ N/mm}^2} \times 1 \times 10^3 \text{ mm} \times 140 \text{ mm}, 0.0013 \times 1 \times 10^3 \text{ mm} \times 140 \text{ mm} \right)$$= 201 \text{ mm}^2$ $A_{s,min} = 201 \text{ mm}^2$	
	Maximum cross sectional area of reinforcement	$A_{s,max} = 0.04 \times h \times b$$= 0.04 \times 200 \text{ mm} \times 1 \times 10^3 \text{ mm}$$= 8000 \text{ mm}^2$	
	Area of longitudinal reinforcement required	$A_{sl,req} = \max (A_{sl,req}, A_{s,min})$$= \max (389 \text{ mm}^2, 201 \text{ mm}^2)$$= 389 \text{ mm}^2$	
Results			
	Area of tension steel required:	$A_{sl,req} = 389 \text{ mm}^2$	
	Utilisation of tension reinforcement provided	$Utl_T = \frac{A_{sl,req}}{A_{s,prov}}$$= \frac{389 \text{ mm}^2}{785 \text{ mm}^2}$$= 0.496$ $Utl_T = 0.496$	
	Area of compression steel required:	$A_{s2,req} = 0 \text{ mm}^2$ $Utl_C = 0$	
Bibliography			
EC0 EN 1990:2002+A1:2005 Eurocode - Basis of structural design EC2-1-1 EN 1992-1-1:2004+A1:2014 Eurocode 2: Design of concrete structures - Part 1-1: General rules and rules for buildings EC2-1-1 UKNA NA+A2:2014 to BS EN 1992-1-1:2004+A1:2014 UK National Annex to Eurocode 2: Design of concrete structures - Part 1-1: General rules and rules for buildings Concrete Centre Guide How to Design Concrete Structures using Eurocode 2 (2011). The Concrete Centre			
Made with ArupCompute			

Thus provide 2 B10 bars each face (4 No. B10 bars each plank) for 200mm thick 3m span planking is satisfactory.

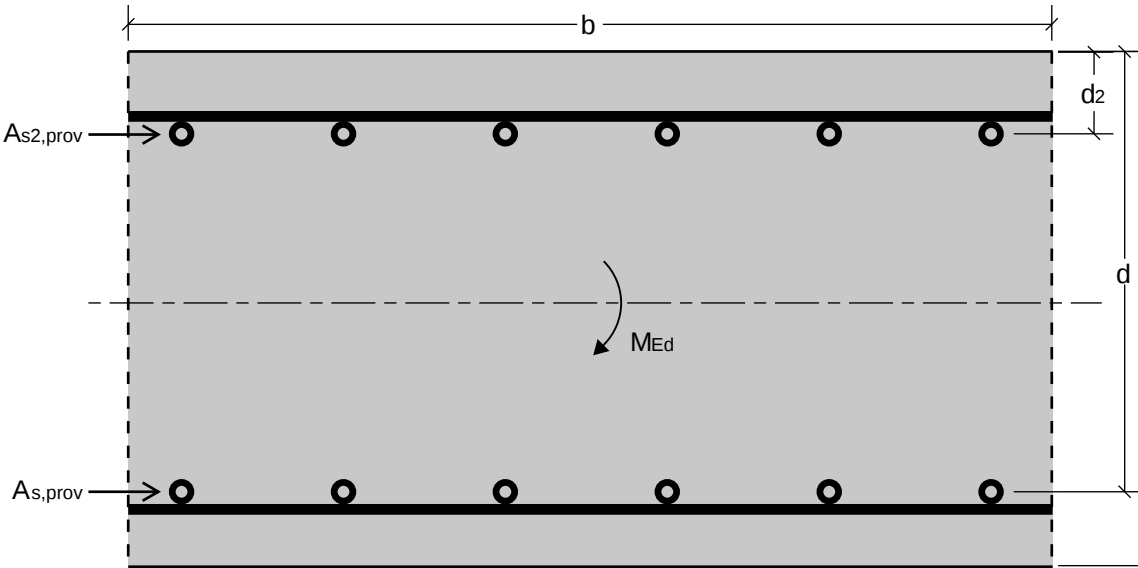
Calculation sheet	Job No.		Rev.
	275375-50		2
	Member Location 2m span concrete plank bending		
Job Title Trebanos headwall	Drg. ref. B16241-102503-01-ZZ-DR-CA-CI5052_C03		
	Made By TY	Date 10-05-2024	Chd. NJ

Area of tension and compression steel required in section subject to bending

Calculates the area of steel required in an RC section to resist a given moment. Implements the equations given in 'How to design concrete structures using Eurocode 2' (The Concrete Centre, 2011), Section 4, Figure 2..

Calculation ID: 1000

Remark: This calculation will only accept a positive value for the applied momemnt and acts in the direction shown below.



Definition of inputs.

Inputs

Overall width of a cross-section, or actual flange width in a T or L beam	$b = 1 \times 10^3 \text{ mm}$
Overall depth of a cross-section	$h = 200 \text{ mm}$
Effective depth of a cross-section	$d = 140 \text{ mm}$
Distance from face in compression to centre of compression reinforcement	$d_2 = 50 \text{ mm}$
Characteristic compressive cylinder strength of concrete at 28 days	$f_{ck} = 28 \text{ N/mm}^2$
Characteristic yield strength of reinforcement	$f_{yk} = 500 \text{ N/mm}^2$
Partial factor for reinforcing or pre-stressing steel	$\gamma_S = 1.15$
Design value of the applied internal bending moment	$M_{Ed} = 10 \text{ kNm}$
Cross-sectional area of reinforcement provided	$A_{s,prov} = 393 \text{ mm}^2$
Area of compression steel provided	$A_{s2,prov} = 393 \text{ mm}^2$

Calculation

Calculation sheet	Job No.		Rev.
	275375-50		2
	Member Location 2m span concrete plank bending		
Job Title Trebanos headwall	Drg. ref. B16241-102503-01-ZZ-DR-CA-CI5052_C03		
	Made By TY	Date 10-05-2024	Chd. NJ
K factor $K = \frac{ M_{Ed} \times 10^6}{b \times d^2 \times f_{ck}}$$= \frac{ 10 \text{ kNm} \times 10^6}{1 \times 10^3 \text{ mm} \times (140 \text{ mm})^2 \times 28 \text{ N/mm}^2}$$= 0.0182$ Maximum value of K before compression reinforcement is required $K' = 0.168$ K <= K' so compression steel is not utilised Area of compressive steel required $A_{s2,req} = 0 \text{ mm}^2$ Lever arm of internal forces $z = \frac{d}{2} \times \left(1 + \sqrt{1 - 3.53 \times K}\right)$$= \frac{140 \text{ mm}}{2} \times \left(1 + \sqrt{1 - 3.53 \times 0.0182}\right)$$= 138 \text{ mm}$ Lever arm of internal forces $z = \min(z, 0.95 \times d)$$= \min(138 \text{ mm}, 0.95 \times 140 \text{ mm})$$= 133 \text{ mm}$ Required area of steel			
Design strength of reinforcing steel Calculate the design (factored) strength of reinforcing steel using the Eurocode partial factor method EC0 6.3.3 (1) Design yield strength of reinforcement $f_{yd} = \frac{f_{yk}}{\gamma_S}$$= \frac{500 \text{ N/mm}^2}{1.15}$$= 435 \text{ N/mm}^2$ See Also BS EN 1992-1-1 Table (2.1) for recommended values of gamma_S $f_{yd} = 435 \text{ N/mm}^2$			
Area of longitudinal reinforcement required $A_{sl,req} = \frac{ M_{Ed} \times 10^6}{z \times f_{yd}}$$= \frac{ 10 \text{ kNm} \times 10^6}{133 \text{ mm} \times 435 \text{ N/mm}^2}$$= 173 \text{ mm}^2$ Limiting areas of steel			
Expression (9.1N) Calculating the minimum allowable area of steel			
Made with AnupCompute			

ARUP Calculation sheet		Job No.	Rev.
		275375-50	2
		Member Location2m span concrete plank bending	
Job TitleTrebanos headwall	Drg. ref. B16241-102503-01-ZZ-DR-CA-CI5052_C03		
	Made ByTY	Date10-05-2024	Chd.NJ
EC2-1-1 (9.1N)	Minimum cross sectional area of reinforcement	$A_{s,min} = \max \left(0.26 \times \frac{f_{ctm}}{f_{yk}} \times b_t \times d, 0.0013 \times b_t \times d \right)$$= \max \left(0.26 \times \frac{2.77 \text{ N/mm}^2}{500 \text{ N/mm}^2} \times 1 \times 10^3 \text{ mm} \times 140 \text{ mm}, 0.0013 \times 1 \times 10^3 \text{ mm} \times 140 \text{ mm} \right)$$= 201 \text{ mm}^2$ $A_{s,min} = 201 \text{ mm}^2$	
	Maximum cross sectional area of reinforcement	$A_{s,max} = 0.04 \times h \times b$$= 0.04 \times 200 \text{ mm} \times 1 \times 10^3 \text{ mm}$$= 8000 \text{ mm}^2$	
	Area of longitudinal reinforcement required	$A_{sl,req} = \max (A_{sl,req}, A_{s,min})$$= \max (173 \text{ mm}^2, 201 \text{ mm}^2)$$= 201 \text{ mm}^2$	
Results			
	Area of tension steel required:	$A_{sl,req} = 201 \text{ mm}^2$	
	Utilisation of tension reinforcement provided	$Utl_T = \frac{A_{sl,req}}{A_{s,prov}}$$= \frac{201 \text{ mm}^2}{393 \text{ mm}^2}$$= 0.512$ $Utl_T = 0.512$	
	Area of compression steel required:	$A_{s2,req} = 0 \text{ mm}^2$ $Utl_C = 0$	
Bibliography			
EC0 EN 1990:2002+A1:2005 Eurocode - Basis of structural design EC2-1-1 EN 1992-1-1:2004+A1:2014 Eurocode 2: Design of concrete structures - Part 1-1: General rules and rules for buildings EC2-1-1 UKNA NA+A2:2014 to BS EN 1992-1-1:2004+A1:2014 UK National Annex to Eurocode 2: Design of concrete structures - Part 1-1: General rules and rules for buildings Concrete Centre Guide How to Design Concrete Structures using Eurocode 2 (2011). The Concrete Centre			
Made with ArupCompute			

Thus provide 1 B10 bars each face (2 No. B10 bars each plank) for 200mm thick 2m span planking is satisfactory.

Calculation sheet	Job No.		Rev.
	275375-50		2
	Member Location2m span concrete planking		
Job Title Trebanos headwall	Drg. ref. B16241-102503-01-ZZ-DR-CA-CI5052_C03		
	Made By TY	Date 10-05-2024	Chd. NJ

Expression (6.2) Shear resistance

Calculates design value for the shear resistance of the member without shear reinforcement

Calculation ID: 1000

Assumptions:

- Refer to EN 1992-1-1 6.2.2 (1) Expression (6.2.a) and (6.2.b)

Inputs

Concrete gradeConcreteGrade = C28_35

The axial force in the cross-section due to loading or pre-stressing (N_{Ed}) for compression). The influence of imposed deformations on N_{Ed} may be ignored.
$$N_{Ed} = 0\text{ N}$$

The area of concrete cross section
$$A_C = 200 \times 10^3\text{ mm}^2$$

Area of the tensile reinforcement, which extends $\geq (l_{bd} + d)$ beyond the section considered (see Figure 6.3)
$$A_{sl} = 393\text{ mm}^2$$

The smallest width of the cross-section in the tensile area
$$b_w = 1000\text{ mm}$$

Effective depth of a cross-section
$$d = 140\text{ mm}$$

National Annex (NA)
$$NA = \text{bs_UK}$$

Calculation

Variable; Factor
$$k = \min \left(1 + \sqrt{\frac{200}{d}}, 2 \right)$$
$$= \min \left(1 + \sqrt{\frac{200}{140\text{ mm}}}, 2 \right)$$
$$= 2$$

Characteristic compressive cylinder strength of concrete at 28 days
$$f_{ck} = 28\text{ N/mm}^2$$

Variable; Factor
$$C_{Rd,c} = \frac{0.18}{\gamma_C}$$
$$= \frac{0.18}{1.5}$$
$$= 0.12$$

Minimum shear resistance
without reinforcement

$$\begin{aligned}
 v_{min} &= 0.035 \times k^{1.5} \times f_{ck}^{0.5} \\
 &= 0.035 \times 2^{1.5} \times (28 \text{ N/mm}^2)^{0.5} \\
 &= 0.524 \text{ MPa}
 \end{aligned}$$

Variable; Factor

$$k_1 = 0.15$$

Reinforcement ratio for
longitudinal reinforcement

$$\begin{aligned}
 \rho_l &= \min \left(\frac{A_{sl}}{b_w \times d}, 0.02 \right) \\
 &= \min \left(\frac{393 \text{ mm}^2}{1000 \text{ mm} \times 140 \text{ mm}}, 0.02 \right) \\
 &= 2.81 \times 10^{-3}
 \end{aligned}$$

Compressive stress in the
concrete from axial load or pre-
stressing

$$\begin{aligned}
 \sigma_{cp} &= \min \left(\frac{N_{Ed}}{A_C}, 0.2 \times f_{cd} \right) \\
 &= \min \left(\frac{0 \text{ N}}{200 \times 10^3 \text{ mm}^2}, 0.2 \times 15.9 \text{ N/mm}^2 \right) \\
 &= 0 \text{ N/mm}^2
 \end{aligned}$$

EC2-1-1 6.2.2 (1) Expression
(6.2.a)Design shear resistance of the
member without shear
reinforcement

$$\begin{aligned}
 V_{Rd,c} &= \left(C_{Rd,c} \times k \times (100 \times \rho_l \times f_{ck})^{0.333} + k_1 \times \sigma_{cp} \right) \times b_w \times d \\
 &= \left(0.12 \times 2 \times (100 \times 2.81 \times 10^{-3} \times 28 \text{ N/mm}^2)^{0.333} + 0.15 \times 0 \text{ N/mm}^2 \right) \times \\
 &\quad 1000 \text{ mm} \times 140 \text{ mm} \\
 &= 66.8 \times 10^3 \text{ N}
 \end{aligned}$$

Conversion from N to kN

$$\begin{aligned}
 V_{Rd,c} &= 66.8 \times 10^3 \text{ N} \times 0.001 \\
 &= 66.8 \text{ kN}
 \end{aligned}$$

EC2-1-1 6.2.2 (1) Expression
(6.2.b)Minimum design shear resistance
of the member without shear
reinforcement

$$\begin{aligned}
 V_{Rd,c,min} &= (v_{min} + k_1 \times \sigma_{cp}) \times b_w \times d \\
 &= (0.524 \text{ MPa} + 0.15 \times 0 \text{ N/mm}^2) \times 1000 \text{ mm} \times 140 \text{ mm} \\
 &= 73.3 \times 10^3 \text{ N}
 \end{aligned}$$

Conversion from N to kN

$$\begin{aligned}
 V_{Rd,c,min} &= 73.3 \times 10^3 \text{ N} \times 0.001 \\
 &= 73.3 \text{ kN}
 \end{aligned}$$

Design shear resistance of the
member without shear
reinforcement

$$\begin{aligned}
 V_{Rd,c} &= \max(V_{Rd,c}, V_{Rd,c,min}) \\
 &= \max(66.8 \text{ kN}, 73.3 \text{ kN}) \\
 &= 73.3 \text{ kN}
 \end{aligned}$$

Design shear force of 2m span concrete plank is 20kN; Design shear force of 3m span concrete plank is 30kN; Both are smaller than shear capacity of 73.3kN. Thus provide 1 B10 bars each face (2 No. B10 bars each plank) for 200mm thick 2m span planking & providing 2 B10 bars each face (4 No. B10 bars each plank) for 200mm thick 3m span planking will be satisfactory.

$$V_{Rd,c} = 73.3 \text{ kN}$$

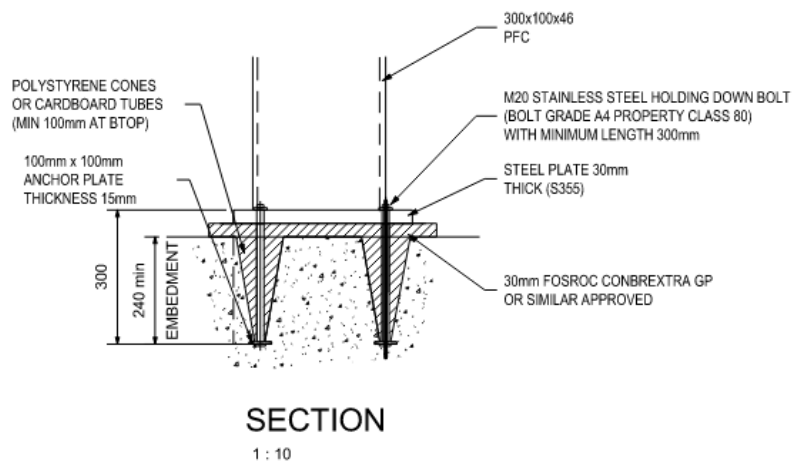
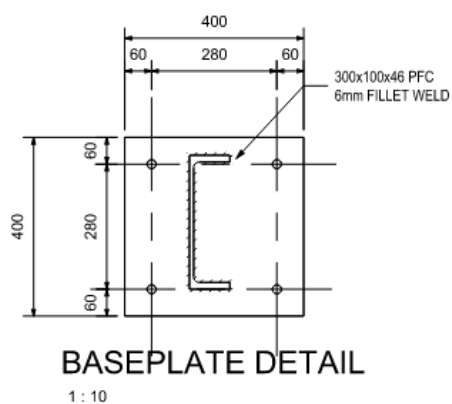
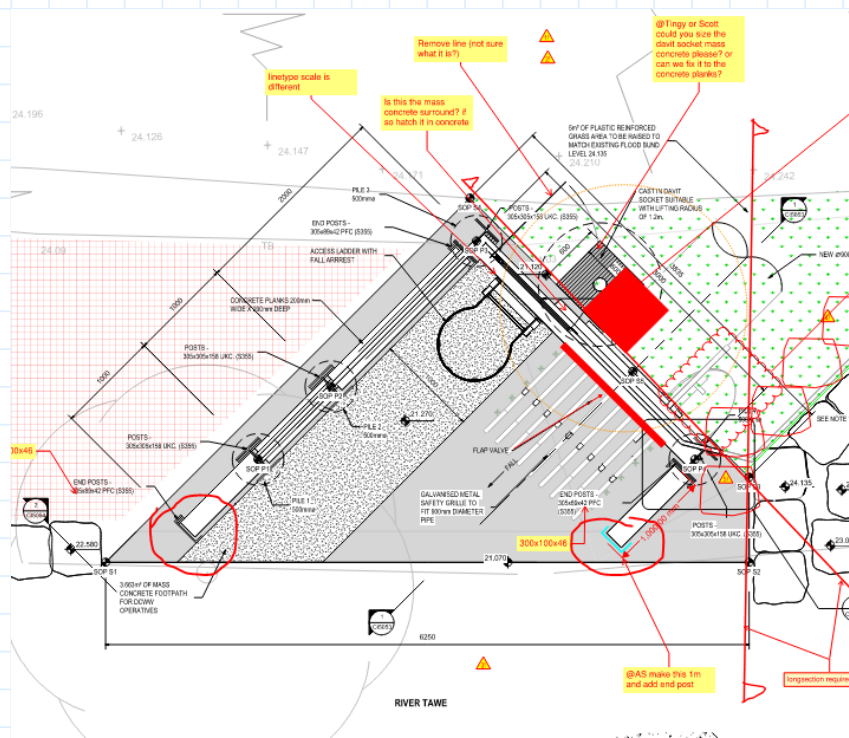
$$V_{Rd,c,min} = 73.3 \text{ kN}$$

Bibliography

EC2-1-1 BS EN 1992-1-1:2004+A1:2014 Eurocode 2: Design of concrete structures - Part 1-1: General rules and rules for buildings

EC2-1-1 UKNA NA+A2:2014 to BS EN 1992-1-1:2004+A1:2014 UK National Annex to Eurocode 2: Design of concrete structures - Part 1-1: General rules and rules for buildings

Trebanos Headwall End Post Steel Section Connection Check



Design Values of forces at ULS

Hi all,

I add below the bending moments which the pile sections would need to be structurally verified for – I'm happy to talk through with a suitable structural engineer for the scheme.

Pile spacing	Minimum toe level for stability	Action effect in pile (DA1C1 factored)	
		Shear force	Bending moment
1.5	+16	60 kN/pile	150 kNm/pile
2.0	+15.5	80 kN/pile	210 kNm/pile
2.5	+15.0	100 kN/pile	280 kNm/pile
3.0	+14.0	120 kN/pile	360 kNm/pile

A DA1C1 factored lateral earth pressure of 20kPa can be used for the structural design of the planking.

Thanks
Scott

Design Moment (conservative approach - assuming it's a 1m tall 0.5m wide canteliver

$$M.ed := \frac{20 \text{ kPa} \cdot (1 \text{ m})^2 \cdot 0.6 \text{ m}}{2} = 6 \text{ kN} \cdot \text{m}$$

Design Shear

$$V.ed := 20 \text{ kPa} \cdot 1 \text{ m} \cdot 0.5 \text{ m} = 10 \text{ kN}$$



Design Axial Force

$$N.ed := 0 \text{ kN}$$

Dimensions and section properties - PFC 300X100X46 (S355)

Depth $h.c := 300 \text{ mm}$

Width $b.c := 100 \text{ mm}$

Flange Thickness $t.fc := 16.5 \text{ mm}$

Web Thickness $t.wc := 9 \text{ mm}$

Root Radium $r.c := 15 \text{ mm}$

Elastic modulus (y-y axis) $W.el.y.c := 549 \text{ cm}^3$

Plastic modulus (y-y axis) $W.pl.y.c := 641 \text{ cm}^3$

Area of cross section $A := 58 \text{ cm}^2$

Ref: Eurocode 3 (In accordance with the UK National Annex) BS3N 10365:2017

Depth between flanges $h.wc := 237 \text{ cm}$

$$h.c - 2 t.fc - 2 \cdot r.c = 0.237 \text{ m} \quad \text{Check}$$

Base Plate

Steel Grade S355 (can this be S275?)

Depth $h.bp := 400 \text{ mm}$

Gross Width $b.g.bp := 400 \text{ mm}$

Thickness $t.bp := 20 \text{ mm}$

Concrete

The concrete grade used for the base is C28/35

Bolts

M20 8.8 bolts S355 non preloaded

Diameter of bolt shank $d := 20 \text{ mm}$

Diameter of hole $d.o := 22 \text{ mm}$ *assumed*

Shear Area per bolt $A.s := 245 \text{ mm}^2$ Ref:p139 of P398

Number of bolts either side $n := 2$

Material Strengths

PFC & Base Plate

For S355 steel and $16\text{mm} < t.fc < 40\text{mm}$

PFC Yield Strength $f.y.pfc := 345 \frac{N}{\text{mm}^2}$ Ref: BS 3N
1993-1-1, N.A.2.4

PFC ultimate Strength $f.u.pfc := 470 \frac{N}{\text{mm}^2}$ BS EN 100252
Table 7

For S355 Steel and $16\text{mm} < t.bp < 40\text{mm}$

Base plate Yield Strength $f.y.bp := 345 \frac{N}{\text{mm}^2}$

Base plate ultimate Strength $f.u.bp := 470 \frac{N}{\text{mm}^2}$

Concrete

For concrete grade C28/35

Characteristic cylinder strength

$$f_{ck} := 28 \text{ MPa}$$

Ref: BS EN 1992 - 1-1,
Table NA.1

$$\alpha_{cc} := 0.85$$

$$\gamma_c := 1.5$$

Design Compressive strength
of the concrete

$$f_{cd} := \frac{\alpha_{cc} \cdot f_{ck}}{\gamma_c}$$

$$f_{cd} = 15.867 \frac{\text{N}}{\text{mm}^2}$$

Bolts

For 8.8 bolts

Nominal yield strength

$$f_{yb} := 640 \frac{\text{N}}{\text{mm}^2}$$

Nominal ultimate strength

$$f_{ub} := 800 \frac{\text{N}}{\text{mm}^2}$$

Partial factors for resistance

Structural Steel

$$\gamma_{M0} := 1$$

$$\gamma_{M1} := 1$$

$$\gamma_{M2} := 1.1$$

Parts in connections

$$\gamma_{M2.p} := 1.25$$

For bolts, welds, plates in
bearing

Distribution of forces at the column base

Forces in PFC flanges

Forces at flange centroids, due to moment

$$N.L.f := \frac{M.ed}{(h.c - t.fc)} = 21.164 \text{ kN}$$

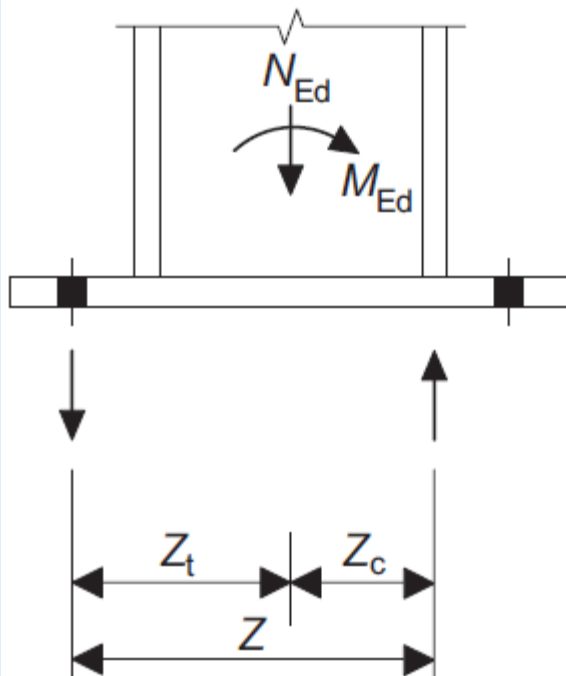
Forces due to axial force

$$N.L.f.n := \frac{N.ed}{2} = 0 \text{ kN}$$

Total forces

$$N.t := N.L.f + N.L.f.n = 21.164 \text{ kN}$$

Forces in T-stubs of base plate



$$Z.t := \frac{h.bp - 40 \text{ mm} \cdot 2 - 20 \text{ mm}}{2} = 150 \text{ mm}$$

$$Z.c := \frac{h.c - t.fc}{2} = 141.75 \text{ mm}$$

$$Z.l := Z.t = 0.15 \text{ m}$$

$$Z.R := Z.c$$

Design force

$$N.LT := \frac{M.ed}{Z.l + Z.R} + \frac{N.ed \cdot Z.R}{Z.l + Z.R} = 20.566 \text{ kN}$$

Resistance of equivalent T-stubs

Bearing Width

$$c := t.bp \cdot \sqrt[2]{\frac{f.y.bp}{3 \cdot f.cd \cdot \gamma.M0}}$$

$$c = 53.844 \text{ mm}$$

$$c := 50 \text{ mm}$$

As the plate is
400mmx400mm...

Thus the dimension of the bearing area are

$$b.eff := 2 \cdot c + t.fc = 116.5 \text{ mm}$$

$$l.eff := 2 \cdot c + b.c = 200 \text{ mm}$$

Area of bearing

$$A.eff := b.eff \cdot l.eff = (2.33 \cdot 10^4) \text{ mm}^2$$

$$F.c.pl.Rd := A.eff \cdot f.cd = 369.693 \text{ kN} \quad \text{bigger than design force 20.6kN}$$

Thus satisfactory

Resistance of the column flange and web in compression

Design Bending Resistance
of the PFC cross section

$$M.c.Rd := 221 \text{ kN} \cdot \text{m}$$

436 / 708

BS EN 1993-1-1:2005
BS 4-1:2005

BENDING

S355 / Advance[®] 355

PARALLEL FLANGE CHANNELS

Advance[®] UKPFC

Designation	Cross section resistance (kNm)	C _t ⁽¹⁾	Buckling Resistance Moment M _{b,Rd} (kNm) for Length between lateral restraints (m)																Second Moment of Area y-y axis I _y cm ⁴
			1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0				
430x100x64			1.00	422	362	310	267	233	205	183	151	129	113	100	90.2	82.2	21900		
			1.13	422	383	333	290	255	226	202	166	141	123	110	99.4	90.8			
			1.35	422	413	366	325	289	259	233	193	163	140	126	114	104			
			1.50	422	422	385	346	310	280	253	211	179	154	136	123	113			
M _{b,y,Rd} = 422			1.77	422	422	414	377	344	314	287	242	207	179	157	139	128			
M _{b,z,Rd} = 33.8			2.00	422	422	422	400	368	339	312	267	230	201	176	156	140			
Class = 1			2.50	422	422	422	422	411	385	360	315	278	246	218	195	175			
380x100x54			1.00	322	279	239	207	181	160	144	119	102	89.0	79.3	71.6	65.3	15000		
			1.13	322	295	257	225	198	176	158	131	111	97.5	87.1	78.8	72.1			
			1.35	322	317	282	251	225	202	182	152	129	111	99.5	90.3	82.8			
			1.50	322	322	297	267	241	218	198	166	141	122	107	97.7	89.7			
			1.77	322	322	318	291	266	244	224	190	163	142	125	111	101			
			2.00	322	322	322	308	285	263	243	209	182	159	140	125	112			
M _{b,y,Rd} = 322			2.50	322	322	322	322	317	297	279	246	218	194	173	156	140			
M _{b,z,Rd} = 30.8																			
Class = 1																			
300x100x46			1.00	221	194	169	149	132	119	108	91.1	79.0	69.9	62.8	57.0	52.3	8230		
			1.13	221	205	181	161	144	130	119	100	86.9	76.5	68.7	62.6	57.5			
			1.35	221	220	198	179	162	148	136	116	101	88.6	78.8	71.3	65.8			
			1.50	221	221	208	189	173	159	147	126	110	97.1	86.4	77.6	71.0			
			1.77	221	221	221	206	190	177	165	144	126	112	100	90.4	81.8			
M _{b,y,Rd} = 221																			

The resistance of the flange and web in compression

$$F.c.fc.Rd := \frac{M.c.Rd}{h.c - t.fc} = 779.541 \text{ kN}$$

Bigger than Design force of 20.6, thus satisfactory

Resistance of base plate in bending

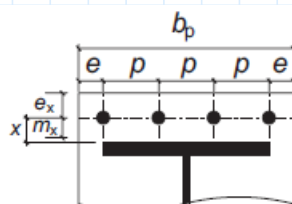
l.eff.1 is the smallest of the following lengths (in which the number of bolts has been taken as n=2)

The distance from the bolt centreline to the fillet weld to the column flange (measured to a distance into the fillet equal to 20% of its size)

$$m.x := \frac{100 \text{ mm}}{2} - 6 \text{ mm}$$

assuming weld fillet is 6mm

$$m.x = 44 \text{ mm}$$



$$e.p := 50 \text{ mm}$$

$$e.x := 25 \text{ mm}$$

$$p := \frac{h.b_p - 2 \cdot e.p}{n - 1} = 300 \text{ mm}$$

Circular Patterns

Individual circular yielding $l_{eff.cp.1} := n \cdot \pi \cdot m.x = 276.46 \text{ mm}$

Individual end yielding $l_{eff.cp.2} := \frac{n}{2} \cdot (\pi \cdot m.x + 2 \cdot e.p) = 238.23 \text{ mm}$

Non- circular patterns

Single Curvature $l_{eff.nc.1} := \frac{h.bp}{2} = 200 \text{ mm}$

Individual End yielding $l_{eff.nc.2} := \frac{n}{2} \cdot (4 \cdot m.x + 1.25 \cdot e.x) = 207.25 \text{ mm}$

Corner yielding of outer bolts, individual yielding between

$$l_{eff.3} := 2 \cdot m.x + 0.625 \cdot e.x + e.p + (n - 2) \cdot (2 \cdot m.x + 0.625 \cdot e.x)$$

$$l_{eff.3} = 153.625 \text{ mm}$$

Group end yielding

$$l_{eff.4} := 2 \cdot m.x + 0.625 \cdot e.x + \frac{(n - 1) \cdot p}{2}$$

$$l_{eff.4} = 253.625 \text{ mm}$$

$$l_{eff.1} := \min(l_{eff.cp.1}, l_{eff.cp.2}, l_{eff.nc.1}, l_{eff.nc.2}, l_{eff.3}, l_{eff.4})$$

$$l_{eff.1} = 153.625 \text{ mm}$$

Plastic Resistance moments

$$M_{pl.1.Rd} := \frac{0.25 \cdot l_{eff.1} \cdot t.bp^2 \cdot f.y.bp}{\gamma.M0} = 5.3 \text{ kN} \cdot \text{m}$$

Mode 1/ Mode 2 Resistance in the absence of prying

$$F_{t.1.2_Rd} := \frac{2 \cdot M_{pl.1.Rd}}{m.x} = 240.912 \text{ kN}$$

bigger than the design force of 17.138kN
Thus Satisfactory

Welds to the flange

$$f.u := \min(f.u.pfc, f.u.bp) = 470 \frac{N}{mm^2}$$

$$K.w := 1.225$$

$$\beta.w := 0.85$$

For a fillet weld with s=6mm, a=4.2mm

$$s.w := 6 \text{ mm}$$

$$a.w := 4.2 \text{ mm}$$

The design resistance due to transverse force is

$$F.nw.Rd := \frac{K.w \cdot \frac{a.w \cdot f.u}{\sqrt{3}}}{\beta.w \cdot \gamma.M2.p} = 1.314 \frac{kN}{mm}$$

Length of weld

Assuming a fillet weld all around the flange: for simplicity, two weld runs will be assumed, along each face of the PFC flange. Conservatively, the thickness of the web will be deducted from the weld inside the flange. An allowance equal to the leg length will be deducted from each end of each weld run.

$$L.weld := b.c - t.wc + b.c - 4 \cdot a.w = 174.2 \text{ mm}$$

$$F.t.weld.Rd := L.weld \cdot F.nw.Rd = 228.898 \text{ kN}$$

Bigger than the design force
of 20.6kN

Thus Satisfactory

Design weld resistances

Leg Length	Throat Thickness	Longitudinal resistance	Transverse resistance
s mm	a mm	$F_{w,L,Rd}$ kN/mm	$F_{w,T,Rd}$ kN/mm
3.0	2.1	0.51	0.62
4.0	2.8	0.68	0.83
5.0	3.5	0.84	1.03
6.0	4.2	1.01	1.24
8.0	5.6	1.35	1.65
10.0	7.0	1.69	2.07
12.0	8.4	2.03	2.48
15.0	10.5	2.53	3.10
18.0	12.6	3.04	3.72
20.0	14.0	3.38	4.14
22.0	15.4	3.71	4.55
25.0	17.5	4.22	5.17

FOR EXPLANATION OF TABLES SEE NOTE 11.2

Second moment of area of PFC with 5.5mm sacrifice

Table 4-2: Recommended value for the loss of thickness [mm] due to corrosion for piles and sheet piles in fresh water or in sea water

Required design working life	5 years	25 years	50 years	75 years	100 years
Common fresh water (river, ship canal,) in the zone of high attack (water line)	0,15	0,55	0,90	1,15	1,40
Very polluted fresh water (sewage, industrial effluent,) in the zone of high attack (water line)	0,30	1,30	2,30	3,30	4,30
Sea water in temperate climate in the zone of high attack (low water and splash zones)	0,55	1,90	3,75	5,60	7,50
Sea water in temperate climate in the zone of permanent immersion or in the intertidal zone	0,25	0,90	1,75	2,60	3,50

Notes:

- 1) The highest corrosion rate is usually found in the splash zone or at the low water level in tidal waters. However, in most cases, the highest bending stresses occur in the permanent immersion zone, see Figure 4-1.
- 2) The values given for 5 and 25 years are based on measurements, whereas the other values are extrapolated.

Table 4-1: Recommended value for the loss of thickness [mm] due to corrosion for piles and sheet piles in soils, with or without groundwater

Required design working life	5 years	25 years	50 years	75 years	100 years
Undisturbed natural soils (sand, silt, clay, schist,)	0,00	0,30	0,60	0,90	1,20
Polluted natural soils and industrial sites	0,15	0,75	1,50	2,25	3,00
Aggressive natural soils (swamp, marsh, peat, ...)	0,20	1,00	1,75	2,50	3,25
Non-compacted and non-aggressive fills (clay, schist, sand, silt,)	0,18	0,70	1,20	1,70	2,20
Non-compacted and aggressive fills (ashes, slag,)	0,50	2,00	3,25	4,50	5,75

Notes:

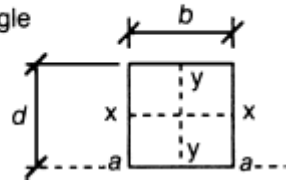
- 1) Corrosion rates in compacted fills are lower than those in non-compacted ones. In compacted fills the figures in the table should be divided by two.
- 2) The values given for 5 and 25 years are based on measurements, whereas the other values are extrapolated.

Check for the reduced section of PFC due to corrosion

Shape

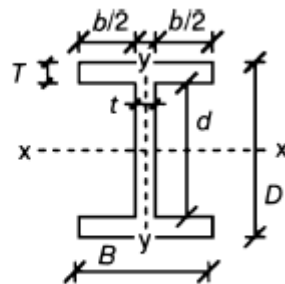
Second moment of area

Rectangle



$$I_{xx} = bd^3/12 \quad I_{yy} = db^3/12$$

I-section



$$I_{xx} = \frac{BD^3 - bd^3}{12}$$

$$I_{yy} = \frac{2TB^3}{12} + \frac{dt^3}{12}$$

Reduced
second
moment of
area

$$I_{sc} := \frac{(b.c - 5.5 \text{ mm}) \cdot (h.c - 5.5 \text{ mm})^3}{12} - \frac{(b.c - t.wc) \cdot (h.c - 2 \cdot t.fc)^3}{12}$$

$$I_{sc} = (5.68 \cdot 10^7) \text{ mm}^4$$

$$y_{sc} := \frac{h.c - t.fc - 5.5 \text{ mm}}{2} = 0.139 \text{ m}$$

Plastic modulus of reduced
section

$$Z_{pl} := \frac{I_{sc}}{y_{sc}} = (4.086 \cdot 10^5) \text{ mm}^3$$

$$\frac{M_{ed}}{Z_{pl}} = 14.683 \frac{\text{N}}{\text{mm}^2}$$

fairly small thus ok

Depth

Width

Flange T

Web Th

Root Ra

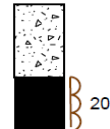
Elastic m

Plastic m

ARUP		Job No.		Sheet No.		Rev.	
						1	
Member/Location		Kingpost wall mass concrete					
Job Title		Trebanos Kingpost Wall					
Calculation		Drg. Ref. B16421-102503-01-ZZ-DR-CA-CI5051					
		Made by	TY	Date	10/05/2024	Chd.	NJ

All references are to BS EN 1992-1-1:2004 inc UK annex, unless stated otherwise

width	1000	mm		
depth	200	mm		
concrete grade (Cyl/Cube)	16/20			
$f_{ctk,0.05}$	1.3	N/mm ²	Table 3.1	
$\alpha_{ct,pl}$	0.8		12.6.3 / table NA.1	
γ_C	1.5		2.4.2.4	
k	1.5		12.6.3	this is for shear stress
Clear span	300	mm	Table 12.1	This is for slenderness check
Effective length beta factor	2		Table 12.1	
Axial load at ULS, N_{Ed}	2	kN	Positive is tension	2
applied moment @ ULS, M_{Ed}	1.8	kNm		(20*0.3^2)
applied shear @ ULS, V_{Ed}	6	kN		20*0.3
				Assume 300mm cantilever
Effective span, l_0	300*2	=	600	mm
slenderness ratio, l_0 / h_w	500/200	=	3.00	
Elastic modulus, $Z = 1000*200^2/6$				
$Z = 6666666.667$	mm ³		Plastic analysis should not be used ref 12.5	
cross section, $A = 1000*200$				
$A = 200000$	mm ²			
Axial stress $2*1000/200000$				
Axial stress 0.0100	N/mm ²		(positive is overall tension)	
Bending stress (tensile fibre) $1.8*1000000/6666666.667$				
Bending stress (tensile fibre) 0.27	N/mm ²			
Extreme fibre combined stress $0.1875+0.0100$			(most-tensile or least-compressive case)	
Extreme fibre combined stress 0.28	N/mm ²		(positive is tension)	
Plain concrete shear $1.5*6*1000/200000$				
τ_{cp} 0.045	N/mm ²		12.6.3	
				$\tau_{cp} = kV_{Ed} / A_{cc}$
Design tensile strength $f_{ctd,pl} = 1.3*0.8/1.5$				
Design tensile strength $f_{ctd,pl}$ 0.693	N/mm ²		12.3.1	
Design shear strength, f_{cvd} 0.693	N/mm ²			



ARUP		Job No.		Sheet No.		Rev.			
						1			
		Member/Location		Kingpost wall mass concrete					
Job Title		Trebanos Kingpost Wall		Drg. Ref.		B16421-102503-01-ZZ-DR-CA-CI5051			
Calculation				Made by	TY	Date	10/05/2024	Chd.	NJ

checks

Informative: bending moment capacity with coincident axial load, assuming no coincident shear

BM capacity (no shear) $\text{MAX}(0, ((0.693 - 0.0100) * 666666.667 / 1000000))$
 $M_{Rd} = 4.556 \quad \text{kNm}$

Stress limit checks:

	actual	limit	PASS/FAIL	
Extreme fibre stress	0.280	0.693	PASS	(without coincident shear)
Shear force stress	0.045	0.693	PASS	(without coincident bending)

To obtain a "principal stress"
resolve these when bending and shear are coincident

	0.284	0.693	PASS	Coincident bending and shear
--	-------	-------	------	------------------------------

WARNING Ian Feltham has advised that resolving these is unconservative - refer to separate advice in the m

Geometry checks:

overall depth	200	120	PASS	12.9.1
slenderness ratio, I_0 / hw	3.00	25	PASS	12.6.5.1

NOTES:

- ALL LEVELS & DIMENSIONS IN METRES UNLESS NOTED OTHERWISE (U.N.O.).
- REFER TO GENERAL NOTES DRAWING FOR DETAILS OF CONCRETE GRADES, COVER, BLINDING, FINISHES ETC.
- EXISTING SERVICES TAKEN FROM AS BUILT RECORDS AND CANNOT BE RELIED UPON FOR ACCURACY. SERVICES HAVE BEEN OBSERVED ON SITE WHERE NO RECORDS ARE AVAILABLE.
- LINE & LEVEL OF EXISTING UTILITIES TO BE CONFIRMED AT START OF CONSTRUCTION.
- PIPE BEDDING TO BE CLASS S AS PER DCWW DETAIL SDC 2003/ 001.
- TRENCH AND ROAD TO BE REINSTATED AS PER DCWW STANDARD DETAIL SDC 2002 SERIES.
- ALL PIPEWORK WITHIN GRASSLAND WITH LESS THAN 0.9m COVER TO BE ENCASED IN MIN 150mm CONCRETE SURROUND AS PER SDC DETAIL 2003/ 003.
- ALL PIPEWORK WITHIN ROAD AND VERGE WITH LESS THAN 1.2m COVER TO BE ENCASED IN MIN 150mm CONCRETE SURROUND AS PER SDC DETAIL 2003/ 003.
- VEGETATION CLEARANCE REQUIRED FOR THE INSTALLATION OF THE NEW HEADWALL. JAPANESE KNOTWEED HAS BEEN NOTED ON THE RIVER BANKS - APPROPRIATE MANAGEMENT PLAN OF INVASIVE SPECIES IS REQUIRED BY THE NRW.
- A FRAP IS REQUIRED PRIOR TO ANY CONSTRUCTION WORKS COMMENCING.
- ANY TEMPORARY OR PERMANENT FOOTPATH DIVERSIONS ARE TO BE ARRANGED BY THE CONTRACTOR.
- THE PRECISE LOCATION OF THE HEADWALL IS TO BE AGREED ON SITE WITH THE ENGINEER FOLLOWING VEGETATION CLEARANCE. ONCE AGREED, SETTING OUT INFORMATION FOR PILES/APRON CAN BE ADJUSTED.
- EXISTING NRW BANK TO BE REINSTATED LIKE FOR LIKE ON COMPLETION OF WORKS.
- CONCRETE STRENGTH CLASS: C28/35 **6F3** SS: DC-2.
- EXCAVATED SLOPES TO BE REINSTATED TO THE PROFILES SHOWN ON THESE DRAWINGS USING CLASS **6N** MATERIAL TO TIE IN WITH THE EXISTING PROFILE. SURFACE RETENTION SHALL COMPRISE A 150mm THICKNESS GEOCELL MATTRESS, BACKFILLED WITH CLASS 6F3 MATERIAL.
- CONCRETE FOOTPATH SHOULD HAVE SLIP-RESISTANT SURFACES. SURFACES SHALL BE SCREEDED WITH A LIGHTLY BRUSHED MARKED FINISH. DEPTH OF ENGINEERED FILL TO BE DESIGNED SUBJECT TO PREVAILING GROUND CONDITIONS. STEP TO BE ARRANGED TO PREVENT PONDING OF WATER. WHERE APPROPRIATE. DIMENSIONS AND SURFACE FINISH TO MEET THE REQUIREMENTS OF BS5395-1:2010. HANDRAILS TO BE PROVIDED IN ACCORDANCE WITH THE DIMENSIONAL REQUIREMENTS OF BS8300:2009 + A2010 AND BS5395-1:2010
- +/-35mm TOLERANCE FOR THE CFA PILES WHERE THE CONTRACTOR CAN NOT ACHIEVE THE SPECIFIED TOLERANCES, THEY SHALL PRECAST THE PLANKS AFTER KING POST CONSTRUCTION TO SUIT AS-BUILT WALL DIMENSIONS

REFERENCE DRAWINGS:

- B16241-103503-01-ZZ-DR-CA-CI5050 - PIPE NETWORK, FINAL EFFLUENT TO OUTFALL, PLAN & PROFILE
- B16421-102503-ZZ-DR-CA-CI5010 HEADWALL GENERAL NOTES
- B16421-102503-XX-XX-SP-SA-CI5401 CONCRETE PILING SPECIFICATION
- B16241-102503-01-ZZ-DR-CA-CI5053 HEADWALL OUTFALL SECTION 1-1
- B16241-102503-01-ZZ-DR-CA-CI5054 HEADWALL OUTFALL SECTION 2-2
- B16241-102503-01-ZZ-DR-CA-CI5055 HEADWALL OUTFALL SECTIONS 3-3 & 4-4

ci5057

10.05.24

C03	DRG REVISED AS CLOUDED	AS	OM	BMB	**05.24
C02	FOR CONSTRUCTION	AS	OM	BMB	01.05.24
C01	FOR CONSTRUCTION	SSJ	GS	BMB	20.03.24
Rev.	Description	Drawn	Chkd.	Appd.	Issue Date



Ty Awen, Spooner Close, Coed Kernew, Newport, NP108FZ

Project Name: TREBANOS WwTW

Drawing Title: HEADWALL OUTFALL PLAN & DETAILS

Suitability: FOR CONSTRUCTION Suitability Code: PA

Originator: SSJ Designer: GS Date: MARCH 24

Internal Project Number: 275281 Scale: As indicated@ A1 Rev: C03

Drawing Number: B16241-102503-01-ZZ-DR-CA-CI5052

SLAB SETTING OUT

REF	EASTING (m)	NORTHING (m)	COMMENTS
SOP1	270938.218	202121.782	
SOP2	270944.466	202121.612	
SOP3	270944.492	202122.565	
SOP4	270941.916	202125.284	
SOP5	270943.505	202123.607	CENTRELINE OF PIPE
SOP6	270943.720	202123.380	
SOP7	270944.628	202124.239	
SOP8	270943.768	202125.147	
SOP9	270942.861	202124.288	

PILE No	TOE LEVEL (m)	EASTING (m)	NORTHING (m)
P1	+16.0	270939.725	202122.741
P2	+15.5	270940.451	202123.428
P3	+15.5	270941.904	202124.804
P4	+15.5	270943.966	202122.626

PILE DEPTHS (SEE NOTE 12)

9.0m² OF EROSION PROTECTION MATTING SEE NOTE 15

N 202125.348
E 270940.540PILE 3
600mmEND POST -
300x100x46 PFC (S355)
SEE NOTE 17

ACCESS LADDER

CONCRETE PLANKS 200mm
WIDE X 200mm DEEPPOST -
305x305x158 UKC. (S355)
SEE NOTE 17PILE 2
600mmPOST -
305x305x158 UKC. (S355)
SEE NOTE 17END POST -
300x100x46 PFC (S355)

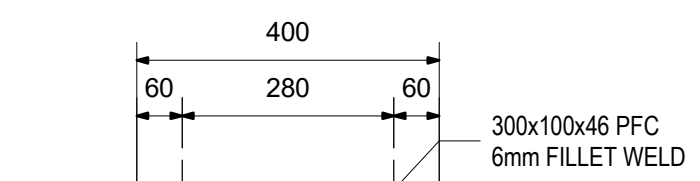
SOP S1

3.830m² OF C28/358
REINFORCED
CONCRETE PLATFORM
FOR DCWW
OPERATIVESLOCKABLE SAFETY
GRILLE TO FIT 900mm
DIAMETER PIPE

RIVER TAWE

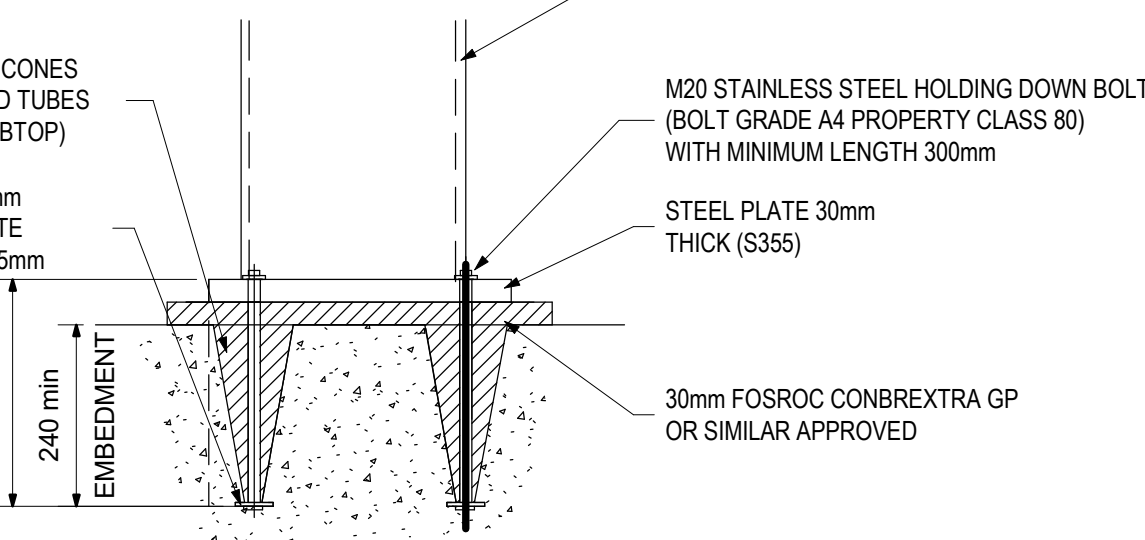
PLAN

1 : 20



BASEPLATE DETAIL

1 : 10



SECTION

1 : 10

DETAIL A

1 : 10

SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION

IN ADDITION TO THE HAZARDS/RISKS NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING, NOTE THE FOLLOWING:

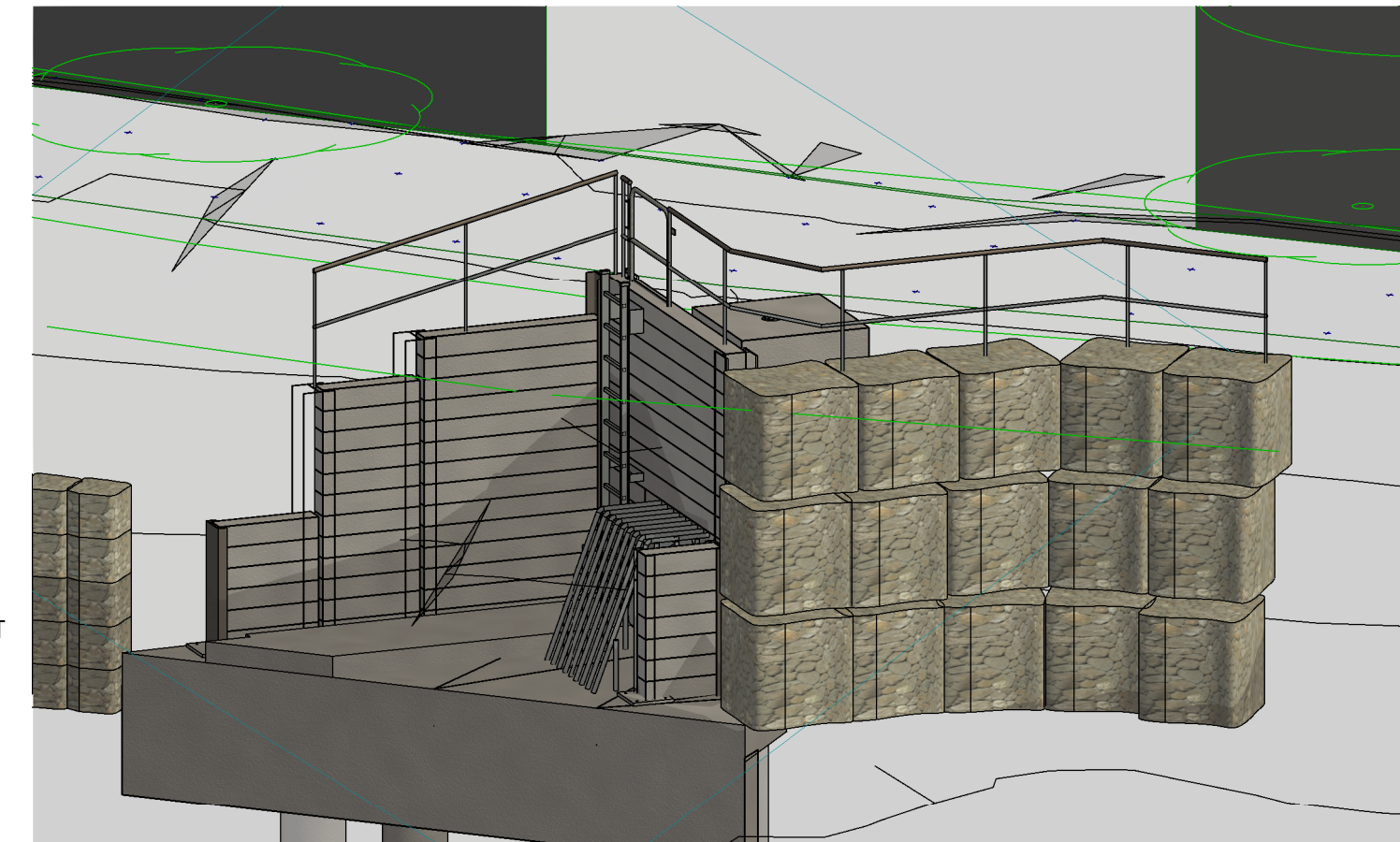
CONSTRUCTION:

- EXISTING GROUND STABILITY AND MAKE UP OF THE FLOOD BUND IS UNKNOWN.
- EXCAVATED MATERIAL COULD BE CONTAMINATED.
- RISK OF DROWNING - WORKING CLOSE TO & WITHIN THE RIVER WITH FLUCTUATING WATER LEVELS.
- ENVIRONMENTAL RISK OF WORKING NEAR A WATERCOURSE.
- CONTRACTOR TO DETERMINE REQUIREMENT FOR PILING MAT AND OTHER TEMPORARY WORKS AND ASSESS STABILITY OF RIVERBANK FOR THEIR SELECTED PLANT
- KNOTWEED PRESENT ON SITE

MAINTENANCE / CLEANING / OPERATION:

DECOMMISSIONING / DEMOLITION:

REFER TO THE DESIGN RISK REGISTER FOR FURTHER DETAILS. IT IS ASSUMED THAT ALL THE WORKS ON THIS DRAWING WILL BE CARRIED OUT BY A COMPETENT CONTRACTOR WHO HAS CARRIED OUT A COMPREHENSIVE RISK ASSESSMENT.



INDICATIVE 3D VIEW

0 0.1 0.2 0.3 0.4 0.5 1.0 1.5 2.0
SCALE 1:20

DWR CYMRU CYF GIVES THIS INFORMATION AS TO THE POSITION OF ITS UNDERGROUND APPARATUS BY WAY OF GENERAL GUIDANCE ONLY ON THE STRICT UNDERSTANDING THAT IT IS BASED ON THE BEST INFORMATION AVAILABLE AND NO WARRANTY AS TO ITS CORRECTNESS IS RELIED UPON IN THE EVENT OF EXCAVATIONS OR OTHER WORKS MADE IN THE VICINITY OF THE COMPANY'S APPARATUS AND ANY ONES OF LOCATING THE APPARATUS BEFORE CARRYING OUT ANY EXCAVATIONS RESTS ENTIRELY ON YOU. IT MUST BE UNDERSTOOD THAT THE FURNISHING OF THE INFORMATION IS ENTIRELY WITHOUT PREJUDICE TO THE PROVISION OF THE NEW PIPES AND STREETWORKS ACT 1997 AND OF THE COMPANY'S RIGHT TO BE COMPENSATED FOR ANY DAMAGE TO ITS APPARATUS.

DWR CYMRU CYF HAS NO DUTY TO IDENTIFY PRIVATE APPARATUS AND THE INFORMATION AS TO THE POSITION OF THE PRIVATE APPARATUS IS GIVEN BY WAY OF GENERAL GUIDANCE ONLY ON THE STRICT UNDERSTANDING THAT IT IS BASED ON THE BEST INFORMATION AVAILABLE AND NO WARRANTY AS TO THE CORRECTNESS IS RELIED UPON NOT ALL PRIVATE APPARATUS IS IDENTIFIED BUT THEIR PRESENCE SHOULD BE ANTICIPATED.

THIS DESIGN AND DRAWING IS CONFIDENTIAL AND ALL RIGHTS THEREIN INCLUDING COPYRIGHT © AND DESIGN RIGHT ARE THE PROPERTY OF DWR CYMRU CYFYNGEDIG AND SHOULD NOT BE DISCLOSED TO A THIRD PARTY OR REPRODUCED WITHOUT PRIOR CONSENT OF DWR CYMRU CYFYNGEDIG.

NOTES:

- ALL LEVELS & DIMENSIONS IN METRES UNLESS NOTED OTHERWISE (U.N.O).
- REFER TO GENERAL NOTES DRAWING FOR DETAILS OF CONCRETE GRADES, COVER, BLINDING, FINISHES ETC.
- EXISTING SERVICES TAKEN FROM AS BUILT RECORDS AND CANNOT BE RELIED UPON FOR ACCURACY. SERVICES HAVE BEEN OBSERVED ON SITE WHERE NO RECORDS ARE AVAILABLE.
- LINE & LEVEL OF EXISTING UTILITIES TO BE CONFIRMED AT START OF CONSTRUCTION.
- PIPE BEDDING TO BE CLASS S AS PER DCWW DETAIL SDC 2003/ 001.
- TRENCH AND ROAD TO BE REINSTATED AS PER DCWW STANDARD DETAIL SDC 2002 SERIES.
- ALL PIPEWORK WITHIN GRASSLAND WITH LESS THAN 0.9m COVER TO BE ENCASED IN MIN 150mm CONCRETE SURROUND AS PER SDC DETAIL 2003/ 003.
- ALL PIPEWORK WITHIN ROAD AND VERGE WITH LESS THAN 1.2m COVER TO BE ENCASED IN MIN 150mm CONCRETE SURROUND AS PER SDC DETAIL 2003/ 003.
- VEGETATION CLEARANCE REQUIRED FOR THE INSTALLATION OF THE NEW HEADWALL. JAPANESE KNOTWEED HAS BEEN NOTED ON THE RIVER BANKS - APPROPRIATE MANAGEMENT PLAN OF INVASIVE SPECIES IS REQUIRED BY THE NRW.
- A FRAP IS REQUIRED PRIOR TO ANY CONSTRUCTION WORKS COMMENCING.
- ANY TEMPORARY OR PERMANENT FOOTPATH DIVERSIONS ARE TO BE ARRANGED BY THE CONTRACTOR.
- THE PRECISE LOCATION OF THE HEADWALL IS TO BE AGREED ON SITE WITH THE ENGINEER FOLLOWING VEGETATION CLEARANCE. ONCE AGREED, SETTING OUT INFORMATION FOR PILES/APRON CAN BE ADJUSTED.
- EXISTING NRW BANK TO BE REINSTATED LIKE FOR LIKE ON COMPLETION OF WORKS.
- CONCRETE STRENGTH CLASS: C28/35; DC CLASS: DC-2.
- CONCRETE FOOTPATH SHOULD HAVE SLIP-RESISTANT SURFACES. SURFACES SHALL BE SCREEDED WITH A LIGHTLY BRUSHED MARKED FINISH. DEPTH OF ENGINEERED FILL TO BE DESIGNED SUBJECT TO PREVAILING GROUND CONDITIONS. STEP TO BE ARRANGED TO PREVENT PONDING OF WATER. WHERE APPROPRIATE. DIMENSIONS AND SURFACE FINISH TO MEET THE REQUIREMENTS OF BS5395-1:2010. HANDRAILS TO BE PROVIDED IN ACCORDANCE WITH THE DIMENSIONAL REQUIREMENTS OF BS8300:2009 + A2010 AND BS5395-1:2010
- UNTIL THE PROPERTIES OF THE EXCAVATED MATERIAL ARE KNOWN, TYPE 1 MATERIAL SHOULD BE ASSUMED FOR ALL BACKFILL.

REFERENCE DRAWINGS:

- B16241-103503-01-ZZ-DR-CA-CI5050 PIPE NETWORK FINAL EFFLUENT TO OUTFALL, PLAN & PROFILE
- B16421-102503-ZZ-ZZ-DR-CA-CI5010 HEADWALL GENERAL NOTES
- B16421-102503-XX-XX-SP-SA-CI5401 CONCRETE PILING SPECIFICATION
- B16241-102503-01-ZZ-DR-CA-CI5052 HEADWALL OUTFALL PLAN & DETAILS
- B16241-102503-01-ZZ-DR-CA-CI5054 HEADWALL OUTFALL SECTION 2-2
- B16241-102503-01-ZZ-DR-CA-CI5055 HEADWALL OUTFALL SECTIONS 3-3 & 4-4

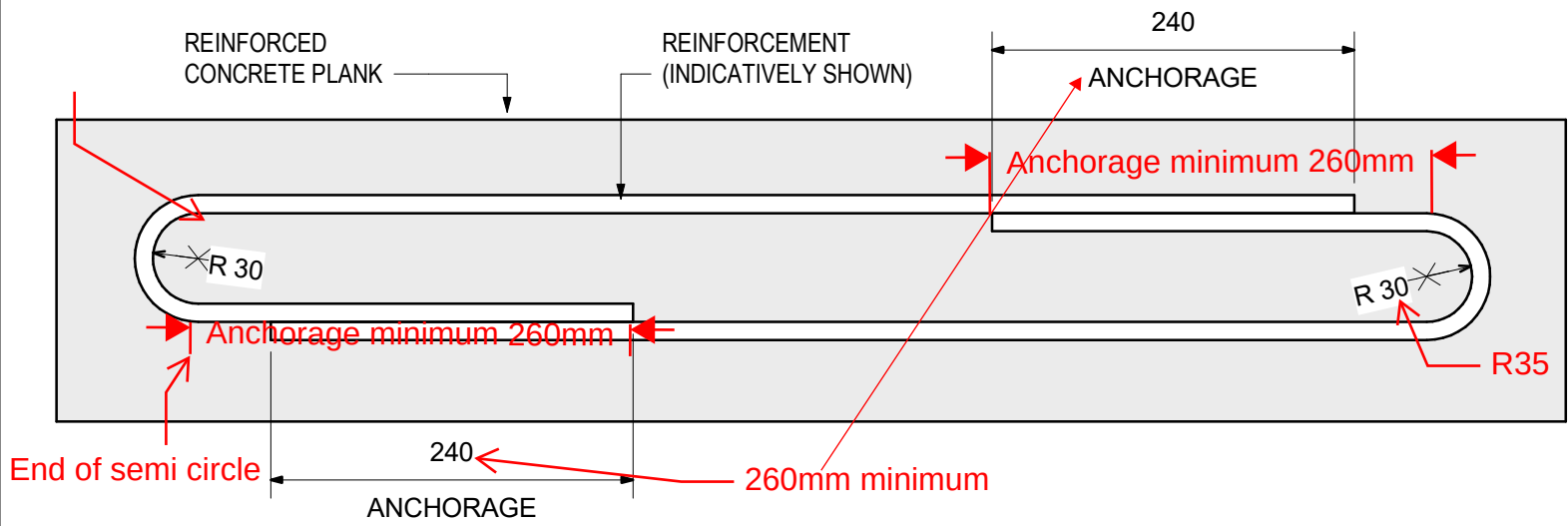
C03	DRG REVISED AS CLOUDED	AS	GS	BMB **05.24
C02	FOR CONSTRUCTION	AS	OM	BMB 01.05.24
C01	FOR CONSTRUCTION	SSJ	GS	BMB 20.03.24
Rev.	Description.	Drawn.	Chkd.	Appd.
Capital Delivery Alliance Cynghair Cyflawni Cyfaloaf				
Ty Awen, Spooner Close, Coed Kernew, Newport, NP108FZ				
Project Name.	TREBANOS WwTW			
Drawing Title.	HEADWALL OUTFALL SECTION 1-1			
Suitability.	FOR CONSTRUCTION			Suitability Code PA
Originator.	SSJ	Designer.	GS	Date. MARCH 24
Internal Project Number.	275281	Scale.	As indicated@ A1	Rev. C03
Drawing Number.	B16241-102503-01-ZZ-DR-CA-CI5053			

DWR CYMRU CYF GIVES THIS INFORMATION AS TO THE POSITION OF ITS UNDERGROUND APPARATUS BY WAY OF GENERAL GUIDANCE ONLY ON THE STRICT UNDERSTANDING THAT IT IS BASED ON THE BEST INFORMATION AVAILABLE AND NO WARRANTY AS TO ITS CORRECTNESS IS RELIED UPON IN THE EVENT OF EXCAVATIONS OR OTHER WORKS MADE IN THE VICINITY OF THE COMPANY'S APPARATUS AND ANY ONES OF LOCATING THE APPARATUS BEFORE CARRYING OUT ANY EXCAVATIONS RESTS ENTIRELY ON YOU. IT MUST BE UNDERSTOOD THAT THE FURNISHING OF THE INFORMATION IS ENTIRELY WITHOUT PREJUDICE TO THE PROVISION OF THE NEW ROADS AND STREETWORKS ACT 1997 AND OF THE COMPANY'S RIGHT TO BE COMPENSATED FOR ANY DAMAGE TO ITS APPARATUS.

DWR CYMRU CYF HAS NO DUTY TO IDENTIFY PRIVATE APPARATUS AND THE INFORMATION AS TO THE POSITION OF THE PRIVATE APPARATUS IS GIVEN BY WAY OF GENERAL GUIDANCE ONLY ON THE STRICT UNDERSTANDING THAT IT IS BASED ON THE BEST INFORMATION AVAILABLE AND NO WARRANTY AS TO THE CORRECTNESS IS RELIED UPON. NOT ALL PRIVATE APPARATUS IS IDENTIFIED BUT THEIR PRESENCE SHOULD BE ANTICIPATED.

BENDING SCHEDULE FOR 3M SPAN CONCRETE PLANK. DIMENSION A IS CUT TO SUITE SITE.

Location	Bar mark	Type and size		Number of members	Number in each	Total number	Length of each bar mm	Shape code	All bending dimensions are in accordance with BS 8666					REV
									A	B	C	D	E/R	
		type	Ø mm						mm	mm	mm	mm	mm	
Concrete plank	13	B	10	1	4	4	3350	13	3000	90	305			



PLAN ON REINFORCED PLANK

1 : 5

1No. of B10 bar each face for 2m&1m span planking (2 No. B10 bars per planking).

EXISTING BOULDERS IN FRONT OF HEADWALL REMOVED. BOULDERS HAVE BEEN ASSUMED AT Z1.465. LEVEL AND SIZE TO BE CONFIRMED AND REINSTATEMENT TO BE AGREED WITH LOCAL AUTHORITIES AND APPROVED BY ENGINEER PRIOR TO CONSTRUCTION

MECHANICAL SUB CONTRACTOR SHALL INSTALL 1.1m HIGH KEE KLAMP HANDRAILING OR SIMILAR APPROVED TO SUIT

RC PLANKS POSITIONED BETWEEN FLANGES OF STRUCTURAL MEMBERS. 200mm DEEP TBC

B10 BARS EACH FACE FOR 2m & 1m SPAN PLANKING

POST - 305x305x158 UKC. (S355)

POST - 305x305x158 UKC. (S355)

EGL SHOWN DASHED GREEN LINETYPE

END POST. 305x100x46 CHANNEL GRADE 355

22.300

21.270

21.070

RIVER TAWE

RIVER BED~ 20.270

1000

300 (MIN)

B12 DOWEL BARS FIXED TO SLAB WITH HILT-HIT-HY-200-A AT 500mm CENTRES MIN. 150mm EMBEDMENT

BACKFILL TO BE SELECTED EXCAVATED MATERIAL OR TYPE 1 SEE NOTE 16

50mm GEN 1 BLINDING

A393 MESH TOP AND BOTTOM

350mm SLAB. C28/35 RC MIX, A393 MESH TOP AND BOTTOM WITH 50mm COVER AND MAX AGGREGATE SIZE 20mm

PILE CUT-OFFS, 75mm INTO BASE

Ø600 BORED PILES (4 No. TOTAL). PILES TOE TO DEPTH SHOWN IN ADJACENT TABLE. WITH STRUCTURAL MEMBERS PLACED VERTICALLY INTO CENTRE OF PILE. SEE PLAN DETAIL FOR POSITION OF PILES

SECTION 1-1

1 : 20

WHERE THE THE PLANKS ARE A MIN. 200mm WIDE ADD 2 NO. B10 BARS EACH FACE FOR 3M PLANKING. CONCRETE GRADE C28/35A. MINIMUM THICKNESS OF PLANKS TO BE 200mm AND UP TO 300mm MAX. TO FILL THE REMAINING GAP BETWEEN UC AND PANEL

1.25m x 1.25m x 600mm DEEP CAST IN DAVIT SOCKET FOR PORATBLE DAVIT, LIFTING RADIUS OF 1.2m

4 No. B10 bars per planking for 3m span planking

PROPOSED EMBANKMENT TO BE CONSTRUCTED WITH SHW CLASS 0N WITH ANGLE OF INTERNAL FRICTION>45°, COMPLYING WITH DETAILED SPECIFICATION FOR SUITABILITY, TESTING, COMPACTION AND MONITORING

EGL TO BE REPROFILED WITH SLOPES NO GREATER THAN 1:3

150mm MIN SEEDED TOPSOIL FREE OF LARGES STONES

24.244 EXISTING TOP OF BUND LEVEL

HEAVY DUTY BLACK POLYTHENE SHEET

@Scott are you happy with this?

Yes

MASS CONCRETE INFILL POUR (GEN3) FILLING BETWEEN THE PIPE ANNULUS AND THE STRUCTURE. MINIMUM THICKNESS 300mm

50mm COMPRESSIBLE FILLER BOARD AEROFIL 2

WALL MOUNTED FLAP VALVE SIZED TO SUIT 900mm PIPE DIAMETER. REFER TO DCWW SPECIFICATION MS102. VALVES. FLAP VALVE IS TO BE POSITIONED AND INSTALLED IN ACCORDANCE WITH MANUFACTURER'S INSTRUCTION AND RECOMMENDATIONS

@Tingyi are you happy with this?

25mm thick around the pipe

Ø900 INLET PIPE. SEE NOTE 5

IL: 21.270

MASS CONCRETE INFILL POUR (GEN3) FILLING BETWEEN THE PIPE ANNULUS AND THE STRUCTURE. MINIMUM THICKNESS 300mm

PILE CUT-OFFS, 75mm INTO BASE

SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION

IN ADDITION TO THE HAZARDS/RISKS NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING, NOTE THE FOLLOWING:

CONSTRUCTION:

- EXISTING GROUND STABILITY AND MAKE UP OF THE FLOOD BUND IS UNKNOWN.
- EXCAVATED MATERIAL COULD BE CONTAMINATED.
- RISK OF DROWNING - WORKING CLOSE TO & WITHIN THE RIVER WITH FLUCTUATING WATER LEVELS.
- ENVIRONMENTAL RISK OF WORKING NEAR A WATERCOURSE.

CONTRACTOR TO DETERMINE REQUIREMENT FOR PILING MAT AND OTHER TEMPORARY WORKS AND ASSESS STABILITY OF RIVERBANK FOR THEIR SELECTED PLANT

WORKS LOCATED WITHING CLOSE PROXIMITY OF FOOTPATH USED BY GENERAL PUBLIC

MAINTENANCE / CLEANING / OPERATION:

DECOMMISSIONING / DEMOLITION:

REFER TO THE DESIGN RISK REGISTER FOR FURTHER DETAILS. IT IS ASSUMED THAT ALL THE WORKS ON THIS SHAWING WILL BE CARRIED OUT BY A COMPETENT CONTRACTOR WHO HAS CARRIED OUT A COMPREHENSIVE RISK ASSESSMENT.



1. ALL LEVELS & DIMENSIONS IN METRES UNLESS NOTED OTHERWISE (U.N.O).
2. REFER TO GENERAL NOTES DRAWING FOR DETAILS OF CONCRETE GRADES, COVER, BLINDING, FINISHES ETC.
3. EXISTING SERVICES TAKEN FROM AS BUILT RECORDS AND CANNOT BE RELIED UPON FOR ACCURACY. SERVICES HAVE BEEN OBSERVED ON SITE WHERE NO RECORDS ARE AVAILABLE.
4. LINE & LEVEL OF EXISTING UTILITIES TO BE CONFIRMED AT START OF CONSTRUCTION.
5. PIPE BEDDING TO BE CLASS S AS PER DOWD DETAIL. SDC 2003/ 001.
6. TRENCH AND ROAD TO BE REINSTATED AS PER DOWD STANDARD DETAIL. SDC 2002 SERIES.
7. ALL PIPEWORK WITHIN GRASSLAND WITH LESS THAN 0.9m COVER TO BE ENCASED IN MIN 150mm CONCRETE SURROUND AS PER SDC DETAIL 2003/ 003.
8. ALL PIPEWORK WITHIN ROAD AND VERGE WITH LESS THAN 1.2m COVER TO BE ENCASED IN MIN 150mm CONCRETE SURROUND AS PER SDC DETAIL 2003/ 003.
9. VEGETATION CLEARANCE REQUIRED FOR THE INSTALLATION OF THE NEW HEADWALL. JAPANESE KNOTWEED HAS BEEN NOTED ON THE RIVER BANKS - APPROPRIATE MANAGEMENT PLAN OF INVASIVE SPECIES IS REQUIRED BY THE NRW.
10. A FRAP IS REQUIRED PRIOR TO ANY CONSTRUCTION WORKS COMMENCING.
11. ANY TEMPORARY OR PERMANENT FOOTPATH DIVERSIONS ARE TO BE ARRANGED BY THE CONTRACTOR.
12. THE PRECISE LOCATION OF THE HEADWALL IS TO BE AGREED ON SITE WITH THE ENGINEER FOLLOWING VEGETATION CLEARANCE. ONCE AGREED, SETTING OUT INFORMATION FOR PILES/APRON CAN BE ADJUSTED.
13. EXISTING NRW BANK TO BE REINSTATED LIKE FOR LIKE ON COMPLETION OF WORKS.
14. CONCRETE STRENGTH CLASS: C28/35; DC CLASS: DC-2.
15. CONCRETE FOOTPATH SHOULD HAVE SLIP-RESISTANT SURFACES. SURFACES SHALL BE SCREEDED WITH A LIGHTLY BRUSHED MARKED FINISH. DEPTH OF ENGINEERED FILL TO BE DENSED SUBJECT TO PREVAILING GROUND CONDITIONS STEP TO BE ARRANGED TO PREVENT PONDING OF WATER. WHERE APPROPRIATE. DIMENSIONS AND SURFACE FINISH TO MEET THE REQUIREMENTS OF BS5395-1:2010. HANDRAILS TO BE PROVIDED IN ACCORDANCE WITH THE DIMENSIONAL REQUIREMENTS OF BS8300:2009 + A2010 AND BS5395-1:2010

- B16241-103503-01-ZZ-DR-CA-C15050 - PIPE NETWORK, FINAL EFFLUENT TO OUTFALL, PLAN & PROFILE
- B16421-102503-ZZ-ZZ-DR-CA-C15010 HEADWALL GENERAL NOTES
- B16421-102503-XX-XX-SP-SA-C15401 CONCRETE PILING SPECIFICATION
- B16241-102503-01-ZZ-DR-CA-C15052 HEADWALL OUTFALL PLAN & DETAILS
- B16241-102503-01-ZZ-DR-CA-C15053 HEADWALL OUTFALL SECTION 1-1
- B16241-102503-01-ZZ-DR-CA-C15055 HEADWALL OUTFALL SECTIONS 3-3 & 4-4

IN ADDITION TO THE HAZARDS/RISKS NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING, NOTE THE FOLLOWING:

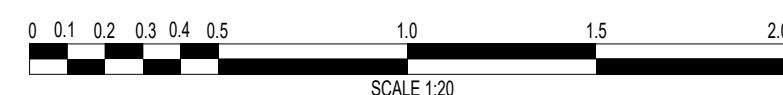
- MAINTENANCE / CLEANING / OPERATION:**

REFER TO THE DESIGN RISK REGISTER FOR FURTHER DETAILS.
IT IS ASSUMED THAT ALL THE WORKS ON THIS DRAWING WILL
BE CARRIED OUT BY A COMPETENT CONTRACTOR WHO HAS
CARRIED OUT A COMPREHENSIVE RISK ASSESSMENT.

DNR CYMRU CŴ GIVES THIS INFORMATION AS TO THE POSITION OF ITS UNDERGROUND APPARATUS BY WAY OF GENERAL GUIDANCE ONLY ON THE STRICT UNDERSTANDING THAT IT IS BASED ON THE BEST INFORMATION AVAILABLE AND NO WARRANTY AS TO ITS CORRECTNESS IS RELIED UPON IN THE EVENT OF EXCAVATIONS OR OTHER WORKS MADE IN THE VICINITY OF THE CAMPANIAN APPARATUS AND ANY OUS OF LOCATING ANY CAMPANIAN APPARATUS OR ANY CAMPANIAN CARVINGS OUT OF ANY CAMPANIAN ROCKS OR ANY OTHER OBJECTS ON VOL IT MUST BE UNDERSTOOD THAT THE FORTHCOMING INFORMATION IS ENTIRELY UNRELIABLE AND NOT TO BE PROVIDED TO THE PROVISION OF THE NEW RIGHTS ACT 1991 AND OF THE COMPANIAN RIGHT TO BE COMPENSATED FOR ANY DAMAGE TO ITS APPARATUS.

DNR CYMRU CŴ HAS NO DUTY TO IDENTIFY PRIVATE APPARATUS AND THE INFORMATION AS TO THE POSITION OF THE PRIVATE APPARATUS IS GIVEN BY WAY OF GENERAL GUIDANCE ONLY ON THE STRICT UNDERSTANDING THAT IT IS BASED ON THE BEST INFORMATION AVAILABLE AND NO WARRANTY AS TO THE CORRECTNESS IS RELIED UPON. NOT ALL PRIVATE APPARATUS IS IDENTIFIED BUT THEIR PRESENCE SHOULD BE ANTICIPATED.

THIS DESIGN AND DRAWING IS CONFIDENTIAL AND ALL RIGHTS THEREIN INCLUDING COPYRIGHT © AND DESIGN RIGHT ARE THE PROPERTY OF DWR CYMRU CYFYNGEDIG AND SHOULD NOT BE DISCLOSED TO A THIRD PARTY OR REPRODUCED WITHOUT PRIOR CONSENT OF DWR CYMRU CYFYNGEDIG.



1 : 20

NOTES:

1. ALL LEVELS & DIMENSIONS IN METRES UNLESS NOTED OTHERWISE (U.N.O).
2. REFER TO GENERAL NOTES DRAWING FOR DETAILS OF CONCRETE GRADES, COVER, BLINDING, FINISHES ETC.
3. EXISTING SERVICES TAKEN FROM AS BUILT RECORDS AND CANNOT BE RELIED UPON FOR ACCURACY. SERVICES HAVE BEEN OBSERVED ON SITE WHERE NO RECORDS ARE AVAILABLE.
4. LINE & LEVEL OF EXISTING UTILITIES TO BE CONFIRMED AT START OF CONSTRUCTION.
5. PIPE BEDDING TO BE CLASS S AS PER DCWW DETAIL SDC 2003/ 001.
6. TRENCH AND ROAD TO BE REINSTATED AS PER DCWW STANDARD DETAIL SDC 2002 SERIES.
7. ALL PIPEWORK WITHIN GRASSLAND WITH LESS THAN 0.9m COVER TO BE ENCASED IN MIN 150mm CONCRETE SURROUND AS PER SDC DETAIL 2003/ 003.
8. ALL PIPEWORK WITHIN ROAD AND VERGE WITH LESS THAN 1.2m COVER TO BE ENCASED IN MIN 150mm CONCRETE SURROUND AS PER SDC DETAIL 2003/ 003.
9. VEGETATION CLEARANCE REQUIRED FOR THE INSTALLATION OF THE NEW HEADWALL. JAPANESE KNOTWEED HAS BEEN NOTED ON THE RIVER BANKS - APPROPRIATE MANAGEMENT PLAN OF INVASIVE SPECIES IS REQUIRED BY THE NRW.
10. A FRAP IS REQUIRED PRIOR TO ANY CONSTRUCTION WORKS COMMENCING.
11. ANY TEMPORARY OR PERMANENT FOOTPATH DIVERSIONS ARE TO BE ARRANGED BY THE CONTRACTOR.
12. THE PRECISE LOCATION OF THE HEADWALL IS TO BE AGREED ON SITE WITH THE ENGINEER FOLLOWING VEGETATION CLEARANCE. ONCE AGREED, SETTING OUT INFORMATION FOR PILES/APRON CAN BE ADJUSTED.
13. EXISTING NRW BANK TO BE REINSTATED LIKE FOR LIKE ON COMPLETION OF WORKS.
14. CONCRETE STRENGTH CLASS: C28/35; DC CLASS: DC-2.
15. CONCRETE FOOTPATH SHOULD HAVE SLIP-RESISTANT SURFACES. SURFACES SHALL BE SCREEDED WITH A LIGHTLY BRUSHED MARKED FINISH. DEPTH OF ENGINEERED FILL TO BE DESIGNED SUBJECT TO PREVAILING GROUND CONDITIONS. STEP TO BE ARRANGED TO PREVENT PONDING OF WATER. WHERE APPROPRIATE. DIMENSIONS AND SURFACE FINISH TO MEET THE REQUIREMENTS OF BS5395-1:2010. HANDRAILS TO BE PROVIDED IN ACCORDANCE WITH THE DIMENSIONAL REQUIREMENTS OF BS8300:2009 + A2010 AND BS5395-1:2010
16. UNTIL THE PROPERTIES OF THE EXCAVATED MATERIAL ARE KNOWN, TYPE 1 MATERIAL SHOULD BE ASSUMED FOR ALL BACKFILL.

REFERENCE DRAWINGS:

- B16241-103503-01-ZZ-DR-CA-CI5050 PIPE NETWORK FINAL EFFLUENT TO OUTFALL, PLAN & PROFILE
- B16421-102503-ZZ-ZZ-DR-CA-CI5010 HEADWALL GENERAL NOTES
- B16421-102503-XX-XX-SP-SA-CI5401 CONCRETE PILING SPECIFICATION
- B16241-102503-01-ZZ-DR-CA-CI5052 HEADWALL OUTFALL PLAN & DETAILS
- B16241-102503-01-ZZ-DR-CA-CI5053 HEADWALL OUTFALL SECTION 1-1
- B16241-102503-01-ZZ-DR-CA-CI5054 HEADWALL OUTFALL SECTIONS 2-2

10.05.24

C01	FOR CONSTRUCTION	AS	GS	BMB	**05.24
Rev.	Description.	Drawn.	Chkd.	Appd.	Issue Date.



Ty Awen, Spooner Close, Coed Kernew, Newport, NP108FZ

Project Name: TREBANOS WwTW

Drawing Title: HEADWALL OUTFALL SECTION 3-3 & 4-4

Suitability: FOR CONSTRUCTION Suitability Code: PA

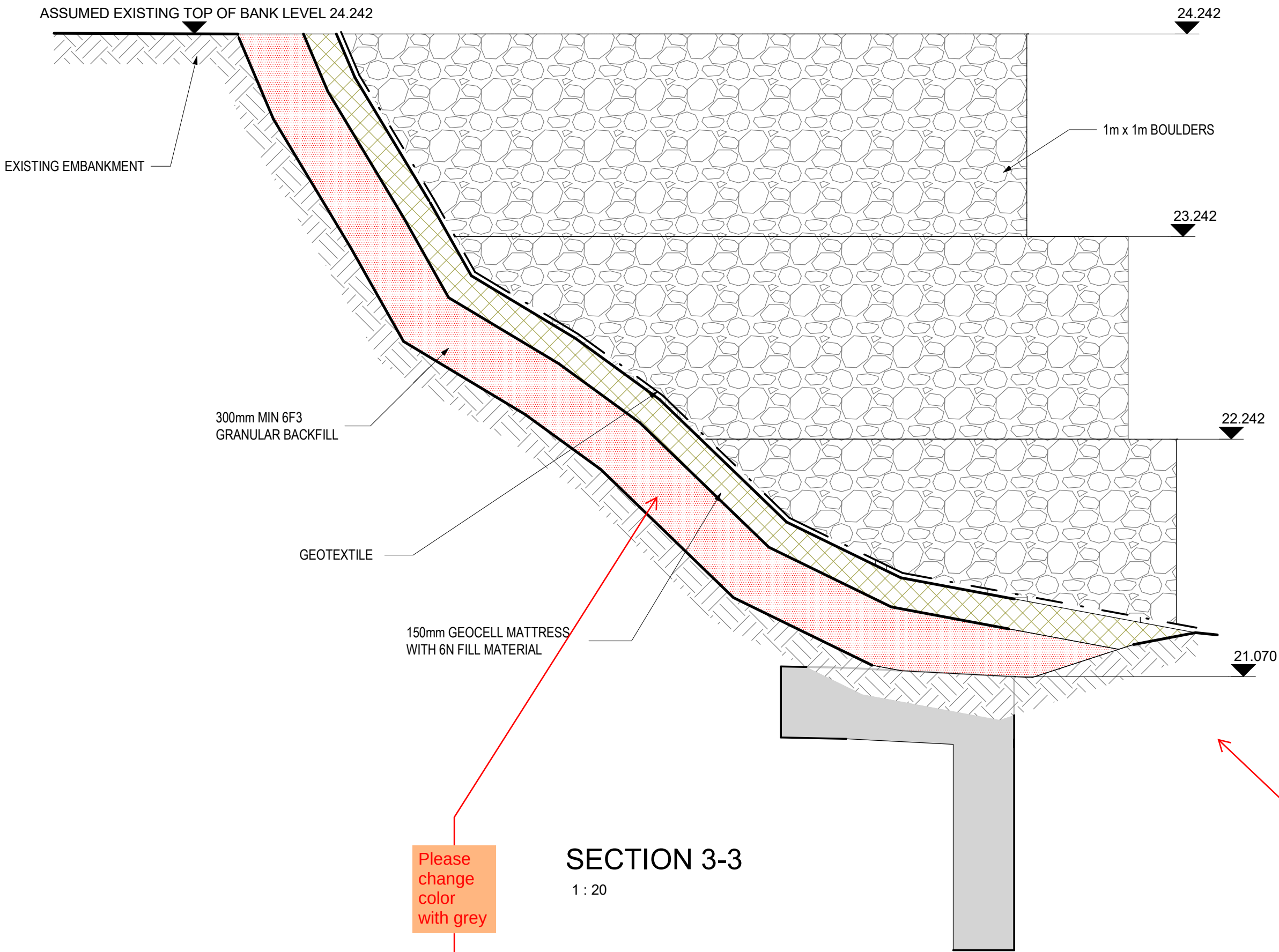
Originator: 275281 Designer: GS Date: 05/07/24

Internal Project Number: 275281 Scale: 1 : 20@ Rev: C01

Drawing Number: B16421-102503-01-ZZ-DR-CA-CI5057

DWR CYMRU CYF GIVES THIS INFORMATION AS TO THE POSITION OF ITS UNDERGROUND APPARATUS BY WAY OF GENERAL GUIDANCE ONLY ON THE STRICT UNDERSTANDING THAT IT IS BASED ON THE BEST INFORMATION AVAILABLE AND NO WARRANTY AS TO ITS CORRECTNESS IS RELIED UPON IN THE EVENT OF EXCAVATIONS OR OTHER WORKS MADE IN THE VICINITY OF THE COMPANY'S APPARATUS AND ANY ONES OF LOCATING THE APPARATUS BEFORE CARRYING OUT ANY EXCAVATIONS RESTS ENTIRELY ON YOU. IT MUST BE UNDERSTOOD THAT THE FURNISHING OF THE INFORMATION IS ENTIRELY WITHOUT PREJUDICE TO THE PROVISION OF THE NEW ROADS AND STREETWORKS ACT 1991 AND OF THE COMPANY'S RIGHT TO BE COMPENSATED FOR ANY DAMAGE TO ITS APPARATUS.

DWR CYMRU CYF HAS NO DUTY TO IDENTIFY PRIVATE APPARATUS AND THE INFORMATION AS TO THE POSITION OF THE PRIVATE APPARATUS IS GIVEN BY WAY OF GENERAL GUIDANCE ONLY ON THE STRICT UNDERSTANDING THAT IT IS BASED ON THE BEST INFORMATION AVAILABLE AND NO WARRANTY AS TO THE CORRECTNESS IS RELIED UPON. NOT ALL PRIVATE APPARATUS IS IDENTIFIED BUT THEIR PRESENCE SHOULD BE ANTICIPATED.



Please change color with grey

