Design Criteria

CROUCH WATERFALL

Project Title:	Job N°	By	Date
St. Ishmaels Sea Defence	*22166*	*RB*	*APR'22*
	Checked *SAG*	Date *APR'22*	Page *00* of *04*

References

Element of Works

Formwork for concrete base

Results

Intended Use

Temporary Works

Loading

Concrete self weight

Standards Adopted

EUROCODES

TWF2012

Formwork - A guide to good practice

Materials

Concrete C35/45

Timber C24

Plywood 18mm (Birch through, 13mm ply)

Metal screws 5mm & 8mm

M16 RAWL: R-KEM+

Design Assumptions / Limitations

Considered wall made by brickwork with strength of 20MPa

Computer Analysis Reference

N/A

Design Check Level

Internal	Internal	External
CAT I	CAT II	CAT III

Checked Internally By:

Sergio Alarcon Gener

Associate

Date: *APR'22*

Approved By:

Julian Howe

Director

Date: *APR'22*

Checked Externally By:

Company:

Date:

Comments

Calculation Sheet

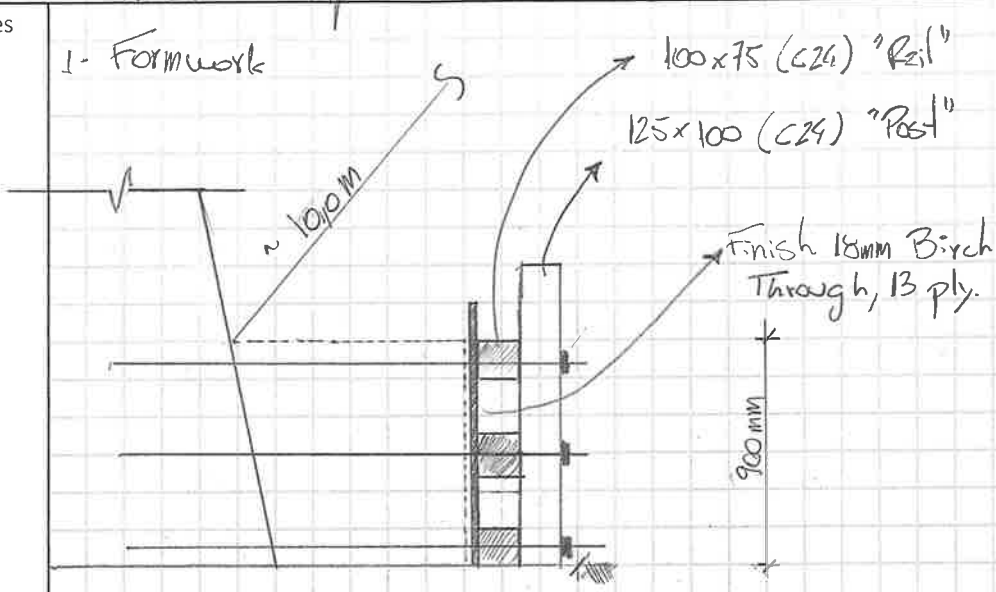
CROUCH WATERFALL

Project Title:	Job No	By	Date
St. Ishmaels - Temp. Works.	2266	RB	Apr '2022
	Checked	Date	Page of
			01 04

References

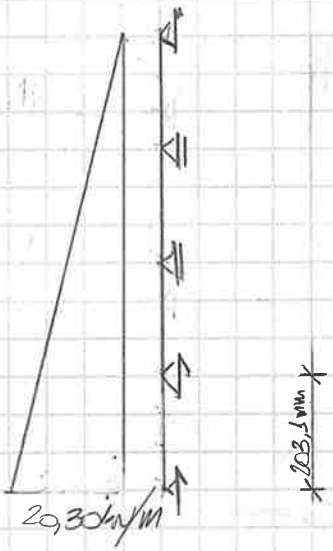
Results

1- Formwork



Concrete pressure: $P = 24 \times 0,90 \Rightarrow P = 21,6$ kPa

distance between posts: 940mm $\therefore q = 21,6 \times 0,94 = 20,30$ kN/m



Bending moment: 0,1 kNm

Shear force: 1,6 kN

Reactions: 3,7 kN

Calculation Sheet

CROUCH WATERFALL

Project Title:	Job No	By	Date
	Checked	Date	Page 02 of

References

Results

*Plywood check

Considered "Finnish 18mm, Birch through 13mm"

Formwork - A Guide... Table 14.

- Bending resistance: $M_{ply.Rd} = 0{,}763$ kNm
- Shear resistance: $V_{ply.Rd} = 16{,}13$ kN

Therefore:

$M_{ply.Ed} = 0{,}1 < M_{ply.Rd} = 0{,}763$ kN.m ok!

$V_{ply.Ed} = 3{,}6 < V_{ply.Rd} = 16{,}13$ kN ok!

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*Rail check

Considered "100 x 75 C24"

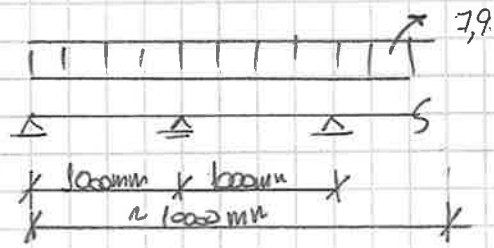
TWF2012 Table C1

- Bending resistance $M_{Rail.Rd} = 0{,}993$ kN.m

  $V_{Rail.Rd} = 7{,}82$ kN

Convert the reaction at the rail point in UDL

$R = \frac{q \cdot l}{2}$ ∴ $3{,}7 = q \cdot \frac{0{,}94}{2}$ → $q = 7{,}9$ kN/m



Calculation Sheet

CROUCH WATERFALL

Project Title:	Job No	By	Date
	Checked	Date	Page 03 of

References

Results

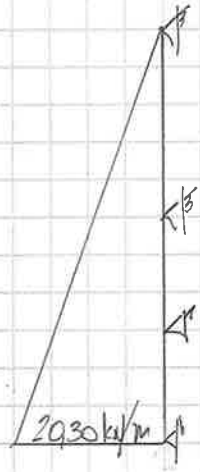
Bending moment: $M_{rail.Ed} = \frac{7,9 \cdot 0,94^2}{8} = 0,872\ kN.m$ (conservative)

Shear force: $V_{rail.Ed} = \frac{7,9 \cdot 0,94}{2} = 3,7\ kN.m$

$M_{rail.Ed} = 0,87\ kN.m < M_{rail.Rd} = 0,993\ kN.m$ ok!

$V_{rail.Ed} = 3,7\ kN < V_{rail.Rd} = 7,82\ kN.m$ ok!!

Post check



bending moment = 0,1 kN.m

shear force = 2.0 kN

reaction = 3,1 kN

considered "125 x 100 C24"

bending resistance = 2,734 kN.m — Table C1

shear force: = 13,15 kN

$M_{post.Ed} = 0,1\ kN.m < M_{post.Rd} = 2,734\ kN.m$ ok!!

$V_{post.Ed} = 2.0\ kN < V_{post.Rd} = 13,15\ kN$ ok!!

Calculation Sheet

CROUCH WATERFALL

Project Title:	Job No	By	Date
	Checked	Date	Page 04 of

References

Results

* Anchors check.

Considered RAWL: R-KEM + M16

↳ Brickwork = 20,5 MPa

Tension resistance = 5,0 kN

min emb. = 500 mm

$R_{anchor.Ed} = 3,1\,kN < R_{anchor,Rd} = 5,0\,kN$ ok !!

Product Information

60-270
R-KEM-300
(300ml)

DESCRIPTION

R-KEM+ is a high performance, styrene free system that is suitable for use in concrete, and other solid or hollow masonry structures. This makes it ideal for applications where conventional expansion anchors present problems.

SUITABLE FOR USE IN:

Concrete
Brickwork
Blockwork
Stone

FEATURES

1. Suitable for solid and hollow substrates.
2. Suitable for overhead applications (with care).
3. R-KEM+ fits a standard mastic gun.
4. Styrene free.
5. Suitable for use in confined spaces

TYPICAL APPLICATIONS

- Curtain walling
- Balustrading
- Handrails
- Canopies
- Rebar

Curing Times

BASE MATERIAL TEMPERATURE (°C)	WORKING TIME	CURING TIME
30	3 mins	25 mins
20	7 mins	50 mins
10	22 mins	1 hour 30 mins
5	30 mins	3 hours 20 mins

Cartridge & Stud Data

STUD THREAD SIZE (mm) (d)	STUD OVERALL LENGTH (mm) (l)	WASHER DIAMETER (mm) (D_w)	MAXIMUM FIXTURE THICKNESS (mm) (T_{fix})	HOLE DIAMETER IN CONCRETE (mm) (d_o)	HOLE DIAMETER IN FIXTURE (mm) (d_f)	STANDARD EMBEDMENT IN CONCRETE (mm) (h_o)	RECOMMENDED TORQUE (Nm) (T_{inst})		STUD PRODUCT CODES				APPROX No. OF HOLES PER 300ML CARTRIDGE
									ZINC PLATED		STAINLESS STEEL GRADE 316 A4		
							CONCRETE	BRICKWORK	PRODUCT CODE	NEW CODE	PRODUCT CODE	NEW CODE	
M8	110	17	17	10	9	80	11	2	60-708	STUDS-08110	60-906	STUDS-08110-A4	66
M10	130	21	28	12	11	90	22	6	60-710	STUDS-10130	60-911	STUDS-10130-A4	48
M12	160	24	36	14	13	110	38	11	60-712	STUDS-12160	60-916	STUDS-12160-A4	33
M16	190	30	42	18	17	125	95	24	60-716	STUDS-16190	60-921	STUDS-16190-A4	22
M20	260	37	90	24	22	145	150	-	60-720	STUDS-20260	60-926	STUDS-20260-A4	6
M20 DEEP	260	37	55	24	22	180	150	-	60-720	STUDS-20260	60-926	STUDS-20260-A4	5
M24	295	44	85	28	26	180	200	-	60-724	STUDS-24295	60-931	STUDS-24295-A4	5
M24 DEEP	295	44	55	28	26	210	200	-	60-724	STUDS-24295	60-931	STUDS-24295-A4	4

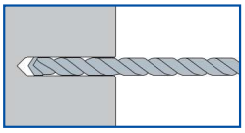
The specification of longer studs will allow greater fixture thicknesses than shown for the standard studs quoted. Minimum embedment should be observed.

Note: For perforated brickwork and hollow block work a mesh sleeve must be inserted into the hole prior to the resin being pumped.

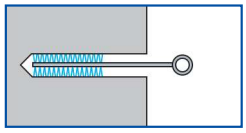
We recommend that for embedment above 500mm and 20mm in diameter a power operated resin gun should be used. Please contact the Rawl Technical Advisory Service for further advice.

Installation

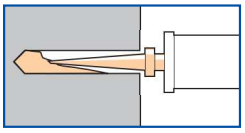
INSTALLATION
Solid substrates



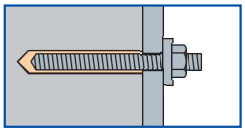
1. Drill hole to correct diameter and depth for stud size being used.



2. Clean the hole using brush and air three times.

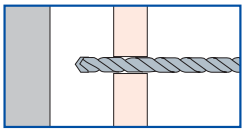


3. Insert cartridge into cartridge gun and attach nozzle. Dispense to waste until an even colour and then pump into hole.

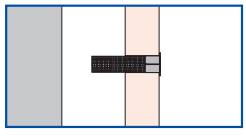


4. Insert stud or socket with a twisting action. Leave the anchor undisturbed until the resin has cured and then attach fixture.

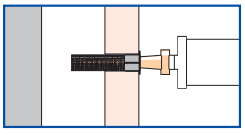
INSTALLATION
Hollow substrates
& substrates with voids



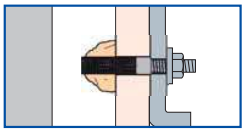
1. Drill hole to correct diameter and depth for mesh sleeve size being used.



2. Insert sleeve into hole.



3. Insert cartridge into cartridge gun and attach nozzle. Dispense to waste until even colour. Then insert nozzle and pump to fill sleeve.



4. Insert stud or socket with a twisting action. Leave the anchor undisturbed until the resin has set and then attach fixture.

Specification Data

Performance Data at Standard Embedment Depth

SIZE	CONCRETE, $f_{ck,cube}$ = 30N/mm² (C20/25)								
	CHARACTERISTIC RESISTANCE (kN)		DESIGN RESISTANCE (Factored) (kN)		RECOMMENDED LOAD (Unfactored) (kN)		CHARACTERISTIC EDGE DISTANCE (mm)		CHARACTERISTIC SPACING (mm)
	TENSION (N_{Rk})	SHEAR (V_{Rk})	TENSION (N_{Rd})	SHEAR (V_{Rd})	TENSION (N_{rec})	SHEAR (V_{rec})	TENSION ($C_{cr,N}$)	SHEAR ($C_{cr,V}$)	TENSION & SHEAR ($S_{cr,N}$) ($S_{cr,V}$)
M8	11.5	9.9	5.1	7.9	3.6	5.7	80	100	100
M10	20.0	15.7	8.3	12.6	5.9	9.0	90	130	130
M12	28.7	22.9	11.5	18.3	8.2	13.1	110	150	150
M16	45.7	42.5	16.6	34.0	11.9	24.3	130	170	170
M20	62.0	66.8	20.9	53.4	15.0	38.2	150	190	210
M20 DEEP	69.7	66.8	23.2	53.4	16.6	38.2	180	190	230
M24	79.3	95.7	26.4	76.6	18.9	54.7	190	240	240
M24 DEEP	87.9	95.7	29.3	76.6	20.9	54.7	220	240	270

For further explanations on calculations please see pages 10 and 11.

SIZE	RECOMMENDED LOAD (kN) (Unfactored) TENSION OR SHEAR (F_{rec})			
	BRICKWORK 20.5N/mm²	BLOCKWORK 7N/mm²	BLOCKWORK 3.5N/mm²	BLOCKWORK 2.8N/mm²
M8	1.4	0.6	0.5	0.4
M10	2.9	1.3	0.9	0.7
M12	4.0	2.0	1.1	0.9
M16	5.0	3.0	SIZES ABOVE M12 ARE NOT RECOMMENDED	
M20	SIZES ABOVE M16 ARE NOT RECOMMENDED			
M24				

When calculating loads in brickwork, apply the published edge distance and spacing for concrete and assume these figures to be the absolute minimums. Concrete reduction factors must NOT be applied.

Reduction Factors – Edge and Spacing Distances

The full characteristic edge and spacing distances shown in the table above are the minimum allowable for the quoted DESIGN RESISTANCE or RECOMMENDED LOAD, depending on your design method. Where these dimensions are not achievable, the appropriate reduction factor/s from the tables below must be applied to the DESIGN RESISTANCE or RECOMMENDED LOAD. Choose the required bolt diameter across the top of the appropriate table and read down the left hand column until actual edge or spacing distance is found. Read off the reduction factor where the two lines intersect (interpolate as required). Multiply this factor by the DESIGN RESISTANCE or RECOMMENDED LOAD quoted in the table. On the occasion that multiple close edge and/or spacing distances occur, the appropriate reduction factors must be applied.

Edge Distance (Concrete Only)

EDGE (mm)	TENSILE : EDGE REDUCTION FACTORS								SHEAR : EDGE REDUCTION FACTORS					
	M8	M10	M12	M16	M20	M20 DEEP	M24	M24 DEEP	M8	M10	M12	M16	M20	M24
50	0.77								0.50					
60	0.85	0.80							0.60	0.50				
70	0.92	0.87	0.78						0.70	0.58	0.50			
80	1.00	0.93	0.84						0.80	0.66	0.57			
90		1.00	0.89	0.82					0.90	0.75	0.64	0.56		
100			0.95	0.86	0.80				1.00	0.83	0.71	0.62	0.56	
110			1.00	0.91	0.84	0.77	0.77			0.92	0.78	0.69	0.61	0.50
130				1.00	0.92	0.83	0.83	0.76		1.00	0.92	0.81	0.72	0.59
150					1.00	0.90	0.90	0.81			1.00	0.94	0.83	0.68
170						0.97	0.96	0.86				1.00	0.94	0.77
180						1.00	0.98	0.89					0.98	0.81
190							1.00	0.92					1.00	0.86
220								1.00						0.97
240														1.00

Spacing (Concrete Only)

SPACING (mm)	TENSILE & SHEAR REDUCTION FACTORS							
	M8	M10	M12	M16	M20	M20 DEEP	M24	M24 DEEP
50	0.80							
60	0.84	0.80						
70	0.88	0.83	0.80					
80	0.92	0.87	0.83					
90	0.96	0.90	0.86	0.81				
100	1.00	0.93	0.88	0.84	0.80			
110		0.97	0.91	0.86	0.82	0.80	0.79	
130		1.00	0.97	0.91	0.86	0.84	0.83	0.80
150			1.00	0.95	0.90	0.87	0.86	0.83
170				1.00	0.94	0.90	0.89	0.86
210					1.00	0.97	0.95	0.92
230						1.00	0.98	0.95
240							1.00	0.97
270								1.00

Performance Data for Reinforcement Bars

If you are bonding rebar into reinforced concrete, where the size, position etc. of the reinforcing is known, then design principles contained within Eurocode 2 can be adopted instead of the design recommendations contained within this manual.

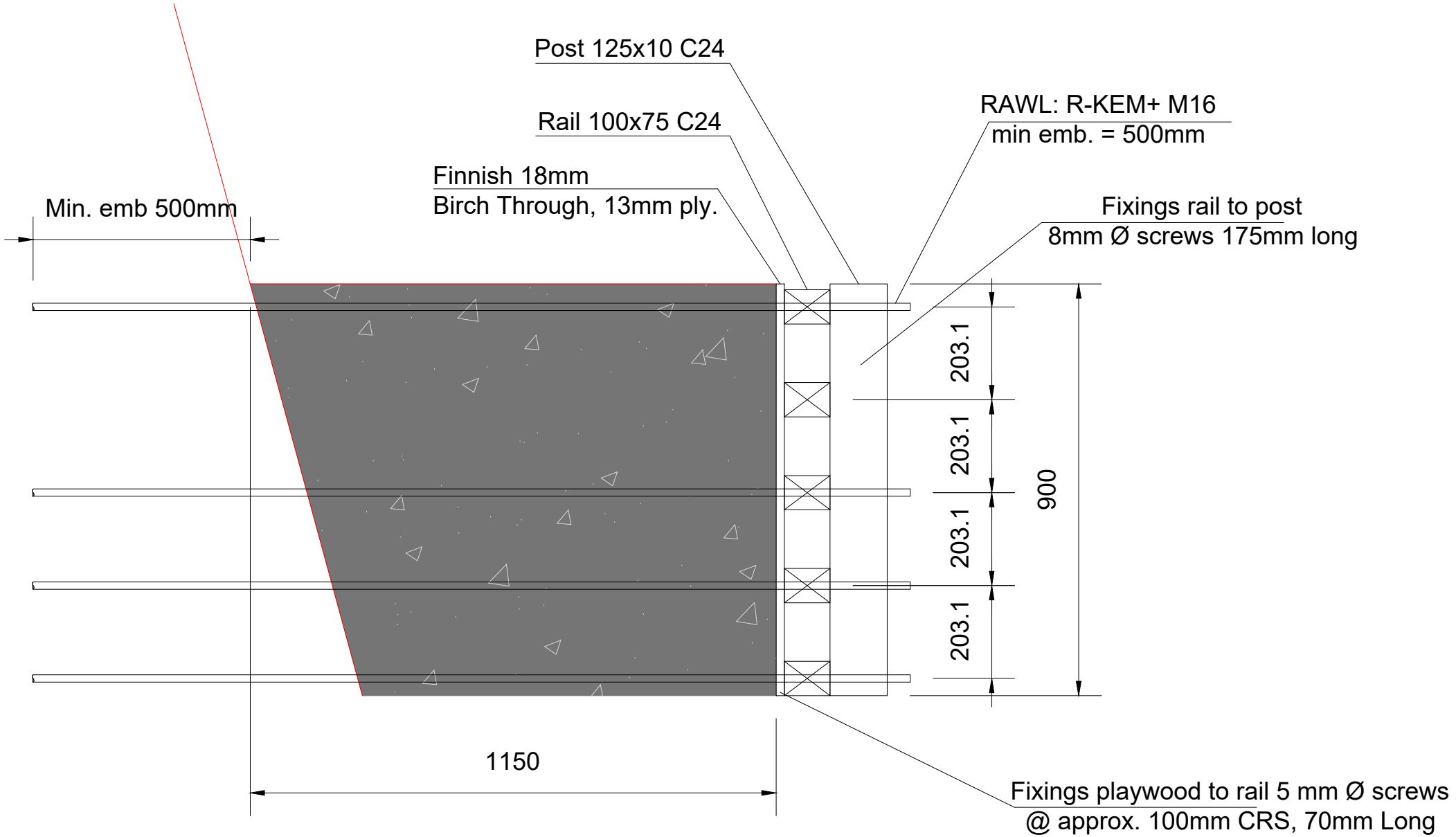
Concrete Strength Class:
C20/25
(25N/mm² 150mm Cylinder; 30N/mm² 150mm Cube).

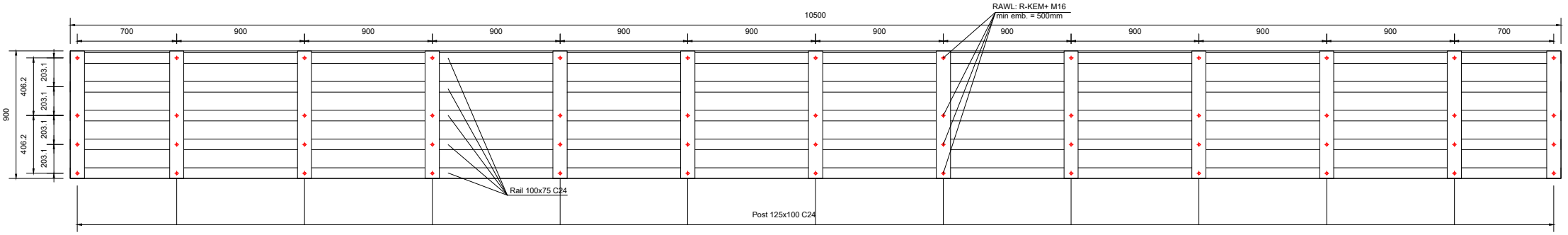
Reinforcement Bar:
Minimum Yield Strength f_{yk} **460N/mm².**

Note: Performance based on clean holes; blown and then brushed with a stiff nylon brush.

REBAR DIA. (mm)	HOLE DIA.	DESIGN RESISTANCE (F_d) (kN)																							EMBEDMENT DEPTH TO FAIL REBAR (mm)
8	10	10.7	13.3	16.0	18.7	21.3	21.9	21.9	21.9	21.9	21.9	21.9	21.9	21.9	21.9	21.9	21.9	21.9	21.9	21.9	21.9	21.9	21.9	21.9	164
10	12		14.9	17.9	20.9	23.8	26.8	29.8	32.8	34.2	34.2	34.2	34.2	34.2	34.2	34.2	34.2	34.2	34.2	34.2	34.2	34.2	34.2	34.2	230
12	15			19.6	22.9	26.1	29.4	32.6	35.9	39.2	42.4	45.7	49.0	49.2	49.2	49.2	49.2	49.2	49.2	49.2	49.2	49.2	49.2	49.2	301
14	18	MINIMUM			24.7	28.2	31.7	35.3	38.8	42.3	45.8	49.4	52.9	56.4	59.9	63.5	66.9	66.9	66.9	66.9	66.9	66.9	66.9	66.9	379
16	20	REBAR DEPTH				30.2	33.9	37.7	41.5	45.2	49.0	52.8	56.5	60.3	64.1	67.9	71.6	75.4	79.2	82.9	86.7	87.4	87.4		464
DEPTH (mm)		80	100	120	140	160	180	200	220	240	260	280	300	320	340	360	380	400	420	440	460	480	500		
20	25	42.1	47.4	52.7	61.8	67.4	78.7	84.3	94.8	105	116	126	137	137	137	137	137	137	137	137	137	137	137	137	648
25	32			56.9	62.6	68.3	79.7	91.1	103	114	125	137	159	182	205	214	214	214	214	214	214	214	214	214	937
32	40	MINIMUM				74.6	87.1	99.5	112	124	137	149	174	199	224	249	274	299	323	350	350	350	350		1406
40	50	REBAR DEPTH						107	121	134	148	161	188	215	241	268	295	322	349	402	456	510	546		2037
DEPTH (mm)		200	225	250	275	300	350	400	450	500	550	600	700	800	900	1000	1100	1200	1300	1500	1700	1900	2100		

REBAR DIA. (mm)	HOLE DIA.	RECOMMENDED LOAD (F_{rec}) (kN)																							EMBEDMENT DEPTH TO FAIL REBAR (mm)
8	10	7.1	8.9	10.7	12.5	14.2	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	164
10	12		9.9	11.9	13.9	15.9	17.9	19.9	21.9	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8	230
12	15			13.1	15.3	17.4	19.6	21.7	23.9	26.1	28.3	30.5	32.7	32.8	32.8	32.8	32.8	32.8	32.8	32.8	32.8	32.8	32.8	32.8	301
14	18	MINIMUM			16.5	18.8	21.1	23.5	25.9	28.2	30.5	32.9	35.3	37.6	39.9	42.3	44.6	44.6	44.6	44.6	44.6	44.6	44.6	44.6	379
16	20	REBAR DEPTH				20.1	22.6	25.1	27.7	30.1	32.7	35.2	37.7	40.2	42.7	45.3	47.7	50.3	52.8	55.3	57.8	58.3	58.3		464
DEPTH (mm)		80	100	120	140	160	180	200	220	240	260	280	300	320	340	360	380	400	420	440	460	480	500		
20	25	28.1	31.6	35.1	41.2	44.9	52.5	56.2	63.2	70.3	77.3	84.3	91.1	91.1	91.1	91.1	91.1	91.1	91.1	91.1	91.1	91.1	91.1	91.1	648
25	32			37.9	41.7	45.5	53.1	60.7	68.3	75.9	84	91	106	121	137	142	142	142	142	142	142	142	142	142	937
32	40	MINIMUM				49.7	58.1	66.3	74.7	83	91	100	116	133	149	166	182	199	216	233	233	233	233		1406
40	50	REBAR DEPTH						71.5	80.5	89	98	107	125	143	161	179	197	215	232	268	304	340	364		2037
DEPTH (mm)		200	225	250	275	300	350	400	450	500	550	600	700	800	900	1000	1100	1200	1300	1500	1700	1900	2100		


Post 125x10 C24
Rail 100x75 C24
Finnish 18mm
Birch Through, 13mm ply.
RAWL: R-KEM+ M16
min emb. = 500mm
Min. emb 500mm
Fixings rail to post
8mm Ø screws 175mm long
203.1
203.1
203.1
203.1
900
1150
Fixings playwood to rail 5 mm Ø screws
@ approx. 100mm CRS, 70mm Long


10500
700
900
900
900
900
900
900
900
900
900
900
900
700
RAWL: R-KEM+ M16
min emb. = 500mm
900
406.2
406.2
203.1
203.1
203.1
203.1
Rail 100x75 C24
Post 125x100 C24