

Robert E. Fry & Associates Ltd.

25650

45 Bridgeman Terrace

Wigan

WN1 1TT

Tel : (01942) 826020

Fax : (01942) 230816

Job Ref : 19192

Sheet : EXTENSION GROUND BEAMS / 001

Made by : MAJ

Date : 10 February 2020 / Ver. 2019.13

Checked :

Approved :

MasterFrame Data File

Loading Cases and Load Combination

Load Group Labels

Load Group UT	Unity Load Factor (All Cases)
Load Group D1	Dead Load
Load Group L1	Live Load

Load Case 001 : Dead plus Live (Ultimate)

Load Combination + 1.00 UT + 1.40 D1 + 1.60 L1

Load Case 002 : Dead Plus Live (PILE LOADS)

Load Combination + 1.00 UT + 1.00 D1 + 1.00 L1

The Nodal Co-ordinates

Node	X (m)	Y (m)	Z (m)	Node	X (m)	Y (m)	Z (m)
1	0.000	0.000	0.000	2	0.600	0.000	0.000
3	6.002	0.000	0.000	4	6.002	0.000	2.062
5	0.000	0.000	3.094	6	0.600	0.000	3.094
7	6.002	0.000	3.094	8	6.002	0.000	4.125
9	0.000	0.000	6.188	10	0.600	0.000	6.188
11	6.002	0.000	6.188				

Member Properties

Members 1-2 & 5-6

M	500x500 E 26.00E6 G 10.0E6		
A 2500E-4	Ix 520833E-8	Iy 520833E-8	J 2083333E-8

Members 3-4

M	400x500 E 26.00E6 G 10.0E6		
A 2000E-4	Ix 416667E-8	Iy 266667E-8	J 1066667E-8

Members 7-8

M	300x300 E 26.00E6 G 10.0E6		
A 900.0E-4	Ix 67500E-8	Iy 67500E-8	J 270000E-8

Members 9-12

M	550x500 E 26.00E6 G 10.0E6		
A 2750E-4	Ix 572917E-8	Iy 693229E-8	J 2291667E-8

Member Loading

Member Self Weight Density Load Included in Load Group D1, defined by Modulus of Elasticity

E kN/mm ²	Density kN/m ³
>= 200.00	77.01
>= 20.00	24.00
>= 2.00	10.00

Members 1-2 & 5-6

D1 UDLY -021.330	(kN/m)
L1 UDLY -007.150	(kN/m)

Members 1-12 - MasterFrame Pro Loads

D1 D 024.000	(kN/m ³)
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Members 3-4

D1 UDLY -022.750	(kN/m)
L1 UDLY -006.000	(kN/m)

Members 9-12

D1 UDLY -024.610	(kN/m)
L1 UDLY -005.900	(kN/m)

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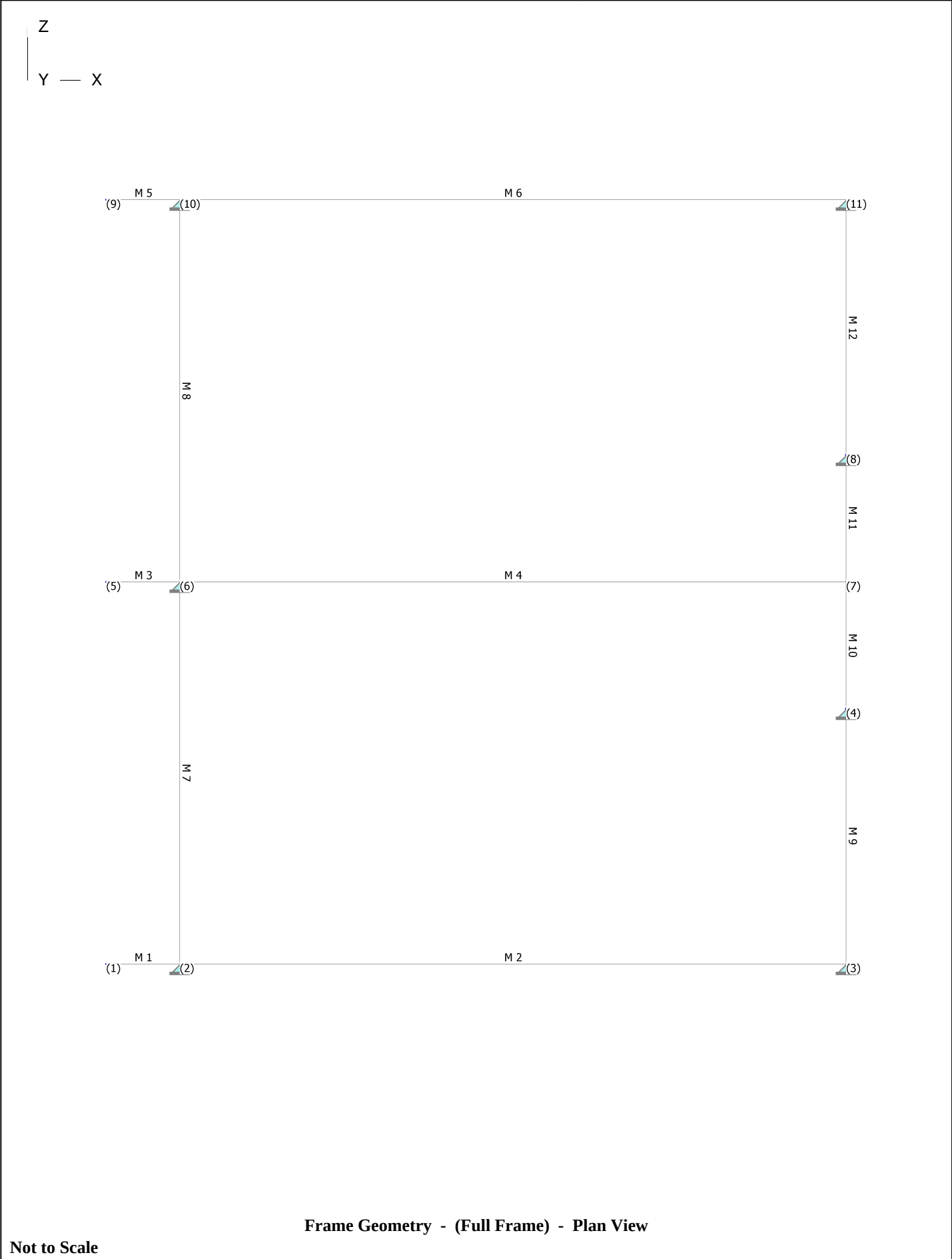
Tel : (01942) 826020

Job Ref : 19192**Sheet : EXTENSION GROUND BEAMS / 002****Made by : MAJ****Date : 10 February 2020 / Ver. 2019.13****Checked :****Approved :****Nodal Loading and Support Conditions**

NODES 2-4, 6, 8 & 10-11

UT RS 1 1 1 0 0 0 (Pinned)

Robert E. Fry & Associates Ltd. 45 Bridgeman Terrace Wigan WN1 1TT Tel : (01942) 826020 25650	Job Ref : 19192 Sheet : EXTENSION GROUND BEAMS / 003 Made by : MAJ Date : 10 February 2020 / Ver. 2019.13 Checked : Approved :
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Not to Scale

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Tel : (01942) 826020

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Sheet : EXTENSION GROUND BEAMS / 004

Made by : MAJ

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Approved :

Nodal Deflections Serviceability (002 : Dead Plus Live (PILE LOADS))

Node	Nodal Def. (mm and Degrees)				Node	Nodal Def. (mm and Degrees)			
	d Y é	F X è	F Z ì	F XZ		d Y é	F X è	F Z ì	F XZ
1	0.98	0.00	-0.09	0.09	2	0.00	0.00	-0.09	0.09
3	0.00	0.00	0.10	0.10	4	0.00	0.00	0.10	0.10
5	1.08	0.00	-0.10	0.10	6	0.00	0.00	-0.10	0.10
7	-0.06	0.00	0.10	0.10	8	0.00	0.00	0.10	0.10
9	0.98	0.00	-0.09	0.09	10	0.00	0.00	-0.09	0.09
11	0.00	0.00	0.10	0.10					

Nodal Deflections Serviceability (Maximum Values)

Node	Nodal Def. (mm and Degrees)				Node	Nodal Def. (mm and Degrees)			
	d Y é	F X è	F Z ì	F XZ		d Y é	F X è	F Z ì	F XZ
1	0.98	0.00	-0.09	0.09	2	0.00	0.00	-0.09	0.09
3	0.00	0.00	0.10	0.10	4	0.00	0.00	0.10	0.10
5	1.08	0.00	-0.10	0.10	6	0.00	0.00	-0.10	0.10
7	-0.06	0.00	0.10	0.10	8	0.00	0.00	0.10	0.10
9	0.98	0.00	-0.09	0.09	10	0.00	0.00	-0.09	0.09
11	0.00	0.00	0.10	0.10					

Nodal Deflections Serviceability (Minimum Values)

Node	Nodal Def. (mm and Degrees)				Node	Nodal Def. (mm and Degrees)			
	d Y é	F X è	F Z ì	F XZ		d Y é	F X è	F Z ì	F XZ
1	0.98	0.00	-0.09	0.09	2	0.00	0.00	-0.09	0.09
3	0.00	0.00	0.10	0.10	4	0.00	0.00	0.10	0.10
5	1.08	0.00	-0.10	0.10	6	0.00	0.00	-0.10	0.10
7	-0.06	0.00	0.10	0.10	8	0.00	0.00	0.10	0.10
9	0.98	0.00	-0.09	0.09	10	0.00	0.00	-0.09	0.09
11	0.00	0.00	0.10	0.10					

Member Forces Ultimate (001 : Dead plus Live (Ultimate))

Mem ber No.	Node End1 End2	Torque Moment (kN.m)	Shear Force (kN)	Bending Moment (kN.m)	Maximum Moment (kN.m @ m)	Maximum Deflection (mm @ m)
1	1	0.000	0.000	0.000	181.528	4.727
	2	0.000	-29.821	-8.946	@ 3.355	@ 3.139
2	2	1.008	136.850	-6.874	181.528	4.727
	3	-1.008	-131.640	7.198	@ 3.355	@ 3.139
3	5	0.000	0.000	0.000	162.104	5.190
	6	0.000	-28.902	-8.670	@ 3.301	@ 3.139
4	6	0.002	129.814	-12.815	162.104	5.190
	7	-0.002	-130.400	-14.397	@ 3.301	@ 3.139
5	9	0.000	0.000	0.000	181.528	4.727
	10	0.000	-29.821	-8.946	@ 3.355	@ 3.139
6	10	-1.006	136.850	-6.874	181.528	4.727
	11	1.006	-131.640	7.198	@ 3.355	@ 3.139

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Sheet : EXTENSION GROUND BEAMS / 005

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Member Forces Ultimate (001 : Dead plus Live (Ultimate))

Mem ber No.	Node End1 End2	Torque Moment (kN.m)	Shear Force (kN)	Bending Moment (kN.m)	Maximum Moment (kN.m @ m)	Maximum Deflection (mm @ m)
7	2 6	2.072	3.997	-1.008	-3.116	0.066
		-2.072	-5.359	-3.114	@ 3.094	@ 1.392
8	6 10	-2.072	5.360	-3.116	-3.116	0.066
		2.072	-3.996	-1.006	@ 3.094	@ 1.392
9	3 4	-7.198	33.451	1.008	52.535	0.091
		7.198	-76.111	-42.975	@ 3.094	@ 3.094
10	4 7	-7.198	119.964	-42.975	52.535	0.091
		7.198	65.129	52.533	@ 3.094	@ 3.094
11	7 8	7.198	-65.271	52.535	52.535	0.091
		-7.198	-120.052	-42.999	@ 3.094	@ 3.094
12	8 11	7.198	76.138	-42.999	52.535	0.091
		-7.198	-33.477	1.006	@ 3.094	@ 3.094

Member Forces Ultimate (Maximum Values)

Mem ber No.	Node End1 End2	Torque Moment (kN.m)	Shear Force (kN)	Bending Moment (kN.m)	Maximum Moment (kN.m @ m)	Maximum Deflection (mm @ m)
1	1 2	0.000	0.000	0.000	181.528	4.727
		0.000	-29.821	-8.946	@ 3.355	@ 3.139
2	2 3	1.008	136.850	-6.874	181.528	4.727
		-1.008	-131.640	7.198	@ 3.355	@ 3.139
3	5 6	0.000	0.000	0.000	162.104	5.190
		0.000	-28.902	-8.670	@ 3.301	@ 3.139
4	6 7	0.002	129.814	-12.815	162.104	5.190
		-0.002	-130.400	-14.397	@ 3.301	@ 3.139
5	9 10	0.000	0.000	0.000	181.528	4.727
		0.000	-29.821	-8.946	@ 3.355	@ 3.139
6	10 11	-1.006	136.850	-6.874	181.528	4.727
		1.006	-131.640	7.198	@ 3.355	@ 3.139
7	2 6	2.072	3.997	-1.008	-3.116	0.066
		-2.072	-5.359	-3.114	@ 3.094	@ 1.392
8	6 10	-2.072	5.360	-3.116	-3.116	0.066
		2.072	-3.996	-1.006	@ 3.094	@ 1.392
9	3 4	-7.198	33.451	1.008	52.535	0.091
		7.198	-76.111	-42.975	@ 3.094	@ 3.094
10	4 7	-7.198	119.964	-42.975	52.535	0.091
		7.198	65.129	52.533	@ 3.094	@ 3.094
11	7 8	7.198	-65.271	52.535	52.535	0.091
		-7.198	-120.052	-42.999	@ 3.094	@ 3.094

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Member Forces Ultimate (Maximum Values)

Mem ber No.	Node End1 End2	Torque Moment (kN.m)	Shear Force (kN)	Bending Moment (kN.m)	Maximum Moment (kN.m @ m)	Maximum Deflection (mm @ m)
12	8 11	7.198 -7.198	76.138 -33.477	-42.999 1.006	52.535 3.094 @	0.091 3.094 @

Member Forces Ultimate (Minimum Values)

Mem ber No.	Node End1 End2	Torque Moment (kN.m)	Shear Force (kN)	Bending Moment (kN.m)	Maximum Moment (kN.m @ m)	Maximum Deflection (mm @ m)
1	1	0.000	0.000	0.000	181.528	4.727
	2	0.000	-29.821	-8.946 @	3.355	@ 3.139
2	2	1.008	136.850	-6.874	181.528	4.727
	3	-1.008	-131.640	7.198 @	3.355	@ 3.139
3	5	0.000	0.000	0.000	162.104	5.190
	6	0.000	-28.902	-8.670 @	3.301	@ 3.139
4	6	0.002	129.814	-12.815	162.104	5.190
	7	-0.002	-130.400	-14.397 @	3.301	@ 3.139
5	9	0.000	0.000	0.000	181.528	4.727
	10	0.000	-29.821	-8.946 @	3.355	@ 3.139
6	10	-1.006	136.850	-6.874	181.528	4.727
	11	1.006	-131.640	7.198 @	3.355	@ 3.139
7	2	2.072	3.997	-1.008	-3.116	0.066
	6	-2.072	-5.359	-3.114 @	3.094	@ 1.392
8	6	-2.072	5.360	-3.116	-3.116	0.066
	10	2.072	-3.996	-1.006 @	3.094	@ 1.392
9	3	-7.198	33.451	1.008	52.535	0.091
	4	7.198	-76.111	-42.975 @	3.094	@ 3.094
10	4	-7.198	119.964	-42.975	52.535	0.091
	7	7.198	65.129	52.533 @	3.094	@ 3.094
11	7	7.198	-65.271	52.535	52.535	0.091
	8	-7.198	-120.052	-42.999 @	3.094	@ 3.094
12	8	7.198	76.138	-42.999	52.535	0.091
	11	-7.198	-33.477	1.006 @	3.094	@ 3.094

Support Reactions Serviceability (002 : Dead Plus Live (PILE LOADS))

Node	Support Reactions (kN and kN.m)			Node	Support Reactions (kN and kN.m)		
	Ry é (kN)	Mx è (kN.m)	Mz ì (kN.m)		Ry é (kN)	Mx è (kN.m)	Mz ì (kN.m)
2	118.500	0.000	0.000	3	114.674	0.000	0.000
4	136.826	0.000	0.000	6	118.169	0.000	0.000
8	136.907	0.000	0.000	10	118.499	0.000	0.000
11	114.693	0.000	0.000	Total	858.268	0.000	0.000

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Support Reactions Serviceability (Maximum Values)

Node	Support Reactions (kN and kN.m)			Node	Support Reactions (kN and kN.m)		
	Ry é (kN)	Mx è (kN.m)	Mz ì (kN.m)		Ry é (kN)	Mx è (kN.m)	Mz ì (kN.m)
2	118.500	0.000	0.000	3	114.674	0.000	0.000
4	136.826	0.000	0.000	6	118.169	0.000	0.000
8	136.907	0.000	0.000	10	118.499	0.000	0.000
11	114.693	0.000	0.000	Total	858.268	0.000	0.000

Support Reactions Serviceability (Minimum Values)

Node	Support Reactions (kN and kN.m)			Node	Support Reactions (kN and kN.m)		
	Ry é (kN)	Mx è (kN.m)	Mz ì (kN.m)		Ry é (kN)	Mx è (kN.m)	Mz ì (kN.m)
2	118.500	0.000	0.000	3	114.674	0.000	0.000
4	136.826	0.000	0.000	6	118.169	0.000	0.000
8	136.907	0.000	0.000	10	118.499	0.000	0.000
11	114.693	0.000	0.000	Total	858.268	0.000	0.000

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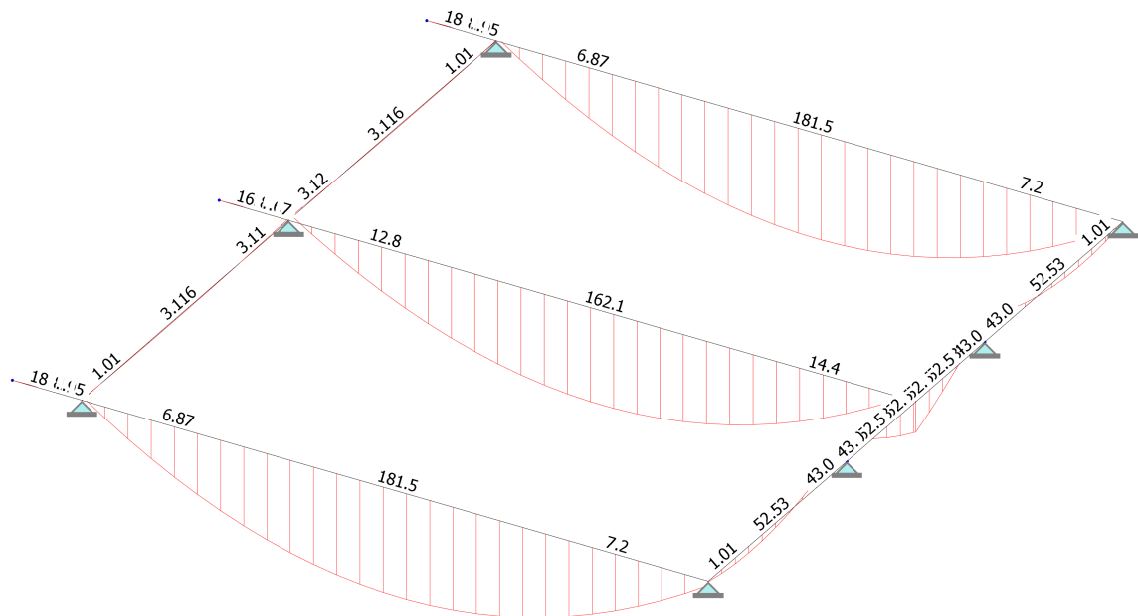
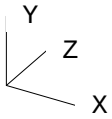
Sheet : EXTENSION GROUND BEAMS / 008

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Load Case 001 : Dead plus Live (Ultimate)

Bending Moment Diagram (Major Axis) - (Full Frame) - 3D Front View

Bending Moment Values (kN.m)

Not to Scale

200 kN.m = 1m

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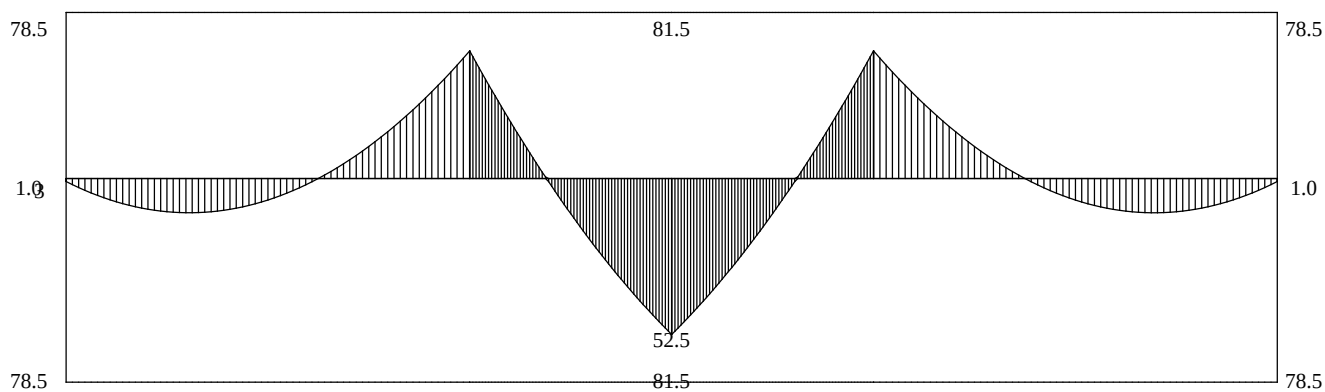
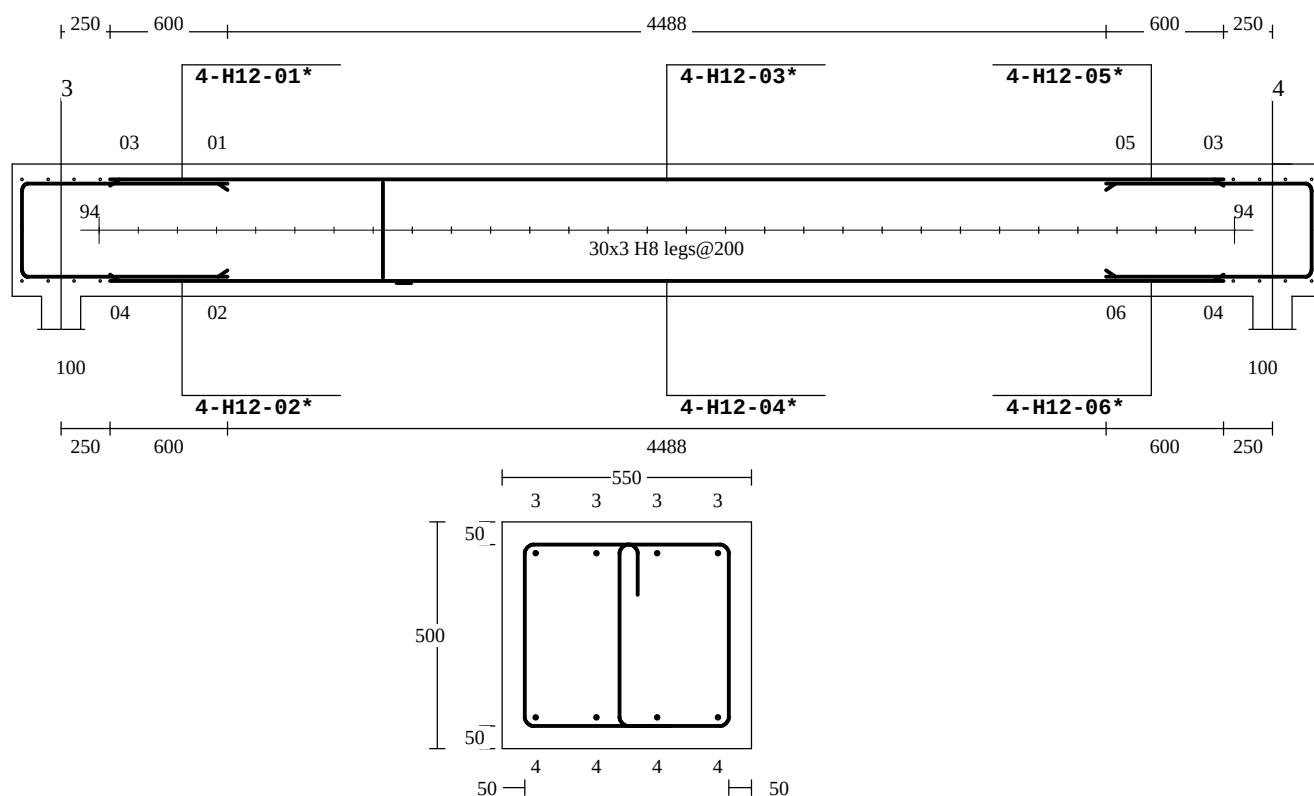
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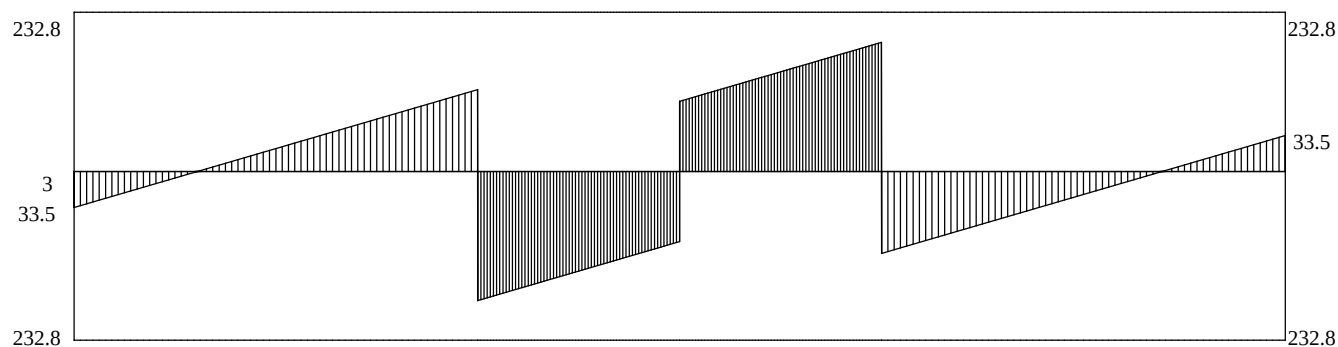
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Member CBL1Id 9 @ Level 1

Bending Moment Envelope



Shear Force Envelope

* Bar mark numbers are local and for guidance only. Do Not use with Bar Schedule

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Sheet : EXTENSION GROUND BEAMS / 010

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Date : 10 February 2020 / Ver. 2019.13

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Member CBL1Id 9 @ Level 1**Basic Data**

Design to BS 8110: 1997
 f_{cu}, f_y, f_{yv}, v crit, K1, K2 35, 500, 500, 4.73, 0.4, 0.45

Torsional Design

Main Rectangular Section assumed to resist Torsion

$T, V_{tmin}, V_{tu(mod)}, H_{min}, H_{max}, X_1, Y_1$ 7.20, 0.40, 3.80, 500, 550, 392, 442(V_{tu} modified to Cl 2.4.5)
 $V_t = 2 \cdot T / (H_{min}^2 (H_{max} - H_{min}/3))$ $2 \times 7.20 / (500^2 \times (550 - 500/3))$ 0.15 N/mm² OK
 Combined $(V + V_t) / V_{tu(mod)} \leq 1$ $(0.501 + 0.150) / 3.804$ 0.171 OK
 $V_t < V_{tmin}$ No Special torsional reinforcement required

Bending Moments**Super-Member Hogging Peak Moment @ 4125 mm. Hogging**

$X/d = F_n(A_s, f_y, K1, B_{eff}, d, f_{cu}, \gamma_m)$ 452, 500, 0.4, 550, 436.0, 35, 0.87 0.06
 $\mu = (K_1 \cdot f_{cu} \cdot B \cdot X) \cdot \min(d - k_2 \cdot X, 0.95 \cdot d)$ $(0.4 \cdot 35 \cdot 550 \cdot 25.6) \cdot (0.95 \cdot 436.0)$ 82 kN.m
 M_{app}/μ 43.0 / 81.5 0.528 OK
 A_s Required to BS8110 Cl 3.4.4.4 Assuming $d = 431, d' = 69$ top 242

In-Span Steel @ 3093 mm. Sagging

$X/d = F_n(A_s, f_y, K1, B_{eff}, d, f_{cu}, \gamma_m)$ 452, 500, 0.4, 550, 436.0, 35, 0.87 0.06
 $\mu = (K_1 \cdot f_{cu} \cdot B \cdot X) \cdot \min(d - k_2 \cdot X, 0.95 \cdot d)$ $(0.4 \cdot 35 \cdot 550 \cdot 25.6) \cdot (0.95 \cdot 436.0)$ 82 kN.m
 M_{app}/μ 52.5 / 81.5 0.645 OK
 A_s Required to BS8110 Cl 3.4.4.4 Assuming $d = 431, d' = 69$ bottom 295 mm²

Shear**Max Shear**

$v_{crit} = \min(5, 0.8 \cdot \sqrt{f_{cu}})$ $\min(5, 0.8 \cdot \sqrt{35})$ 4.733 N/mm²
 $v = V_{max} / (d \cdot b)$ $120 \cdot 1000 / (420 \cdot 550)$ 0.520 N/mm² OK

Nominal Shear Zone at 520 mm

$v_c = F_n(A_s, b_v, d, f_{cu})$ 452, 550, 436, 35 0.41 N/mm² Table 3.8
 $V_{cap} = F_n(A_{sv}, S_v, b_v, d, f_{yv}, v_c)$ 151, 200, 550, 436, 500, 0.41 240.4 kN Table 3.7
 V/V_{cap} 5.8/ 240.4 0.024 OK

Nominal Shear Zone at 5667 mm

$v_c = F_n(A_s, b_v, d, f_{cu})$ 452, 550, 436, 35 0.41 N/mm² Table 3.8
 $V_{cap} = F_n(A_{sv}, S_v, b_v, d, f_{yv}, v_c)$ 151, 200, 550, 436, 500, 0.41 240.4 kN Table 3.7
 V/V_{cap} 5.8/ 240.4 0.024 OK

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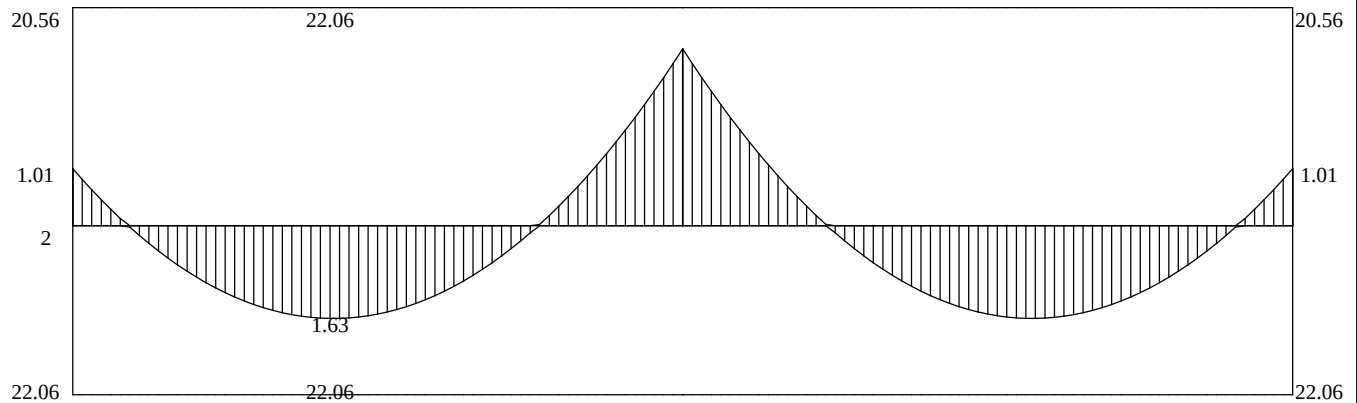
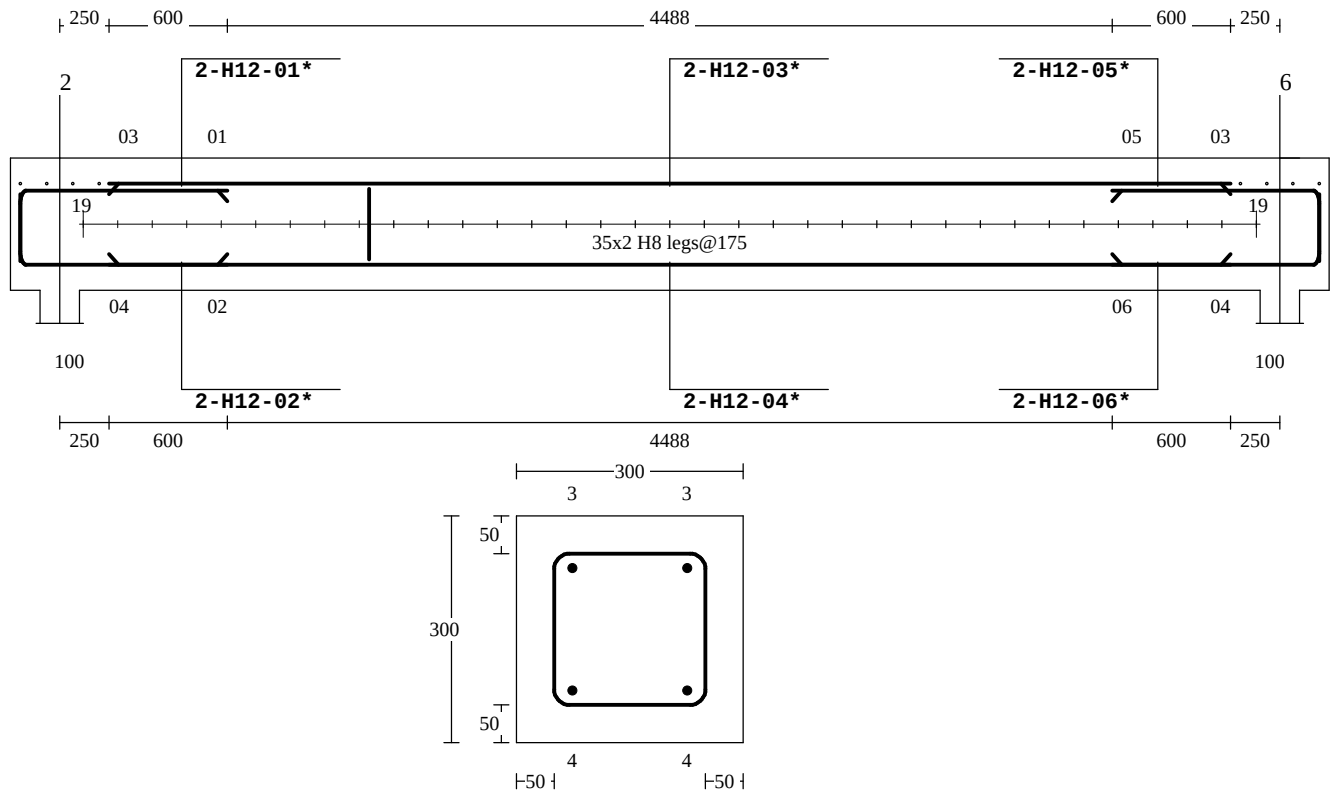
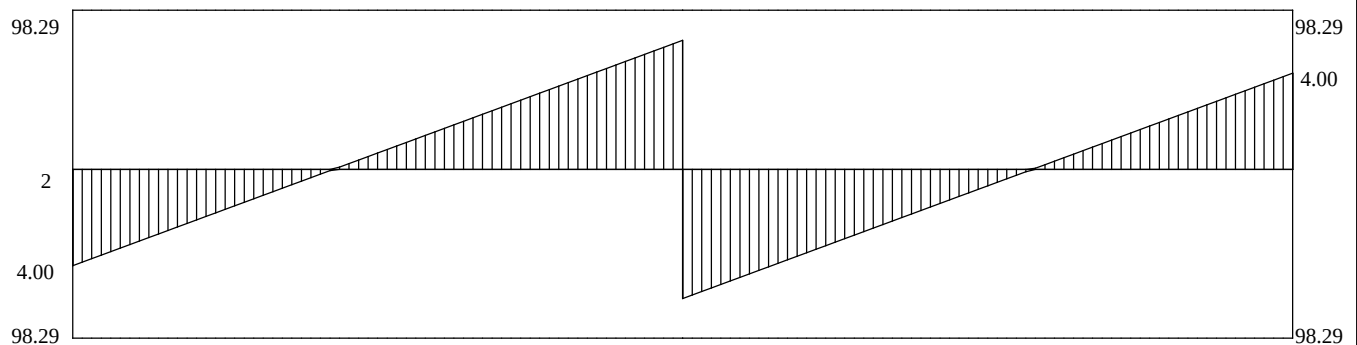
Sheet : EXTENSION GROUND BEAMS / 011

Made by : MAJ

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Approved :

Member CBL1Id 7 @ Level 1**Bending Moment Envelope****Shear Force Envelope**

* Bar mark numbers are local and for guidance only. Do Not use with Bar Schedule

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Tel : (01942) 826020

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Sheet : EXTENSION GROUND BEAMS / 012

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Checked :

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Member CBL1Id 7 @ Level 1**Basic Data**

Design to BS 8110: 1997
 f_{cu} , f_y , f_{yv} , v crit, K1, K2 35, 500, 500, 4.73, 0.4, 0.45

Torsional Design

Main Rectangular Section assumed to resist Torsion

T , V_{tmin} , $V_{tu(mod)}$, H_{min} , H_{max} , X_1 , Y_1 2.07, 0.40, 1.65, 300, 300, 192, 192(V_{tu} modified to Cl 2.4.5)
 $V_t = 2 \cdot T / (H_{min}^2 (H_{max} - H_{min}/3))$ $2 \times 2.07 / (300^2 \times (300 - 300/3))$ 0.23 N/mm² OK
 Combined $(V + V_t) / V_{tu(mod)} \leq 1$ $(0.076 + 0.230) / 1.652$ 0.185 OK
 $V_t < V_{tmin}$ No Special torsional reinforcement required

Bending Moments**Super-Member Hogging Peak Moment @ 3093 mm. Hogging**

$X/d = F_n(A_s, f_y, K1, Beff, d, f_{cu}, \gamma_m)$ 226, 500, 0.4, 300, 236.0, 35, 0.87 0.1
 $\mu = (K_1 \cdot f_{cu} \cdot B \cdot X) \cdot \min(d - k_2 \cdot X, 0.95 \cdot d)$ $(0.4 \cdot 35 \cdot 300 \cdot 23.5) \cdot (0.95 \cdot 236.0)$ 22 kN.m
 M_{app}/μ 3.1 / 22.1 0.141 OK
 A_s Required to BS8110 Cl 3.4.4.4 Assuming $d = 231$, $d' = 69$ top 33

Left Support Steel Hogging

$X/d = F_n(A_s, f_y, K1, Beff, d, f_{cu}, \gamma_m)$ 226, 500, 0.4, 300, 220.0, 35, 0.87 0.11
 $\mu = (K_1 \cdot f_{cu} \cdot B \cdot X) \cdot \min(d - k_2 \cdot X, 0.95 \cdot d)$ $(0.4 \cdot 35 \cdot 300 \cdot 23.5) \cdot (0.95 \cdot 220.0)$ 21 kN.m
 M_{app}/μ 1.0 / 20.6 0.049 OK
 A_s Required to BS8110 Cl 3.4.4.4 Assuming $d = 231$, $d' = 69$ top 11

In-Span Steel @ 1305 mm. Sagging

$X/d = F_n(A_s, f_y, K1, Beff, d, f_{cu}, \gamma_m)$ 226, 500, 0.4, 300, 236.0, 35, 0.87 0.1
 $\mu = (K_1 \cdot f_{cu} \cdot B \cdot X) \cdot \min(d - k_2 \cdot X, 0.95 \cdot d)$ $(0.4 \cdot 35 \cdot 300 \cdot 23.5) \cdot (0.95 \cdot 236.0)$ 22 kN.m
 M_{app}/μ 1.6 / 22.1 0.074 OK
 A_s Required to BS8110 Cl 3.4.4.4 Assuming $d = 231$, $d' = 69$ bottom 17 mm²

Right Support Steel Hogging

$X/d = F_n(A_s, f_y, K1, Beff, d, f_{cu}, \gamma_m)$ 226, 500, 0.4, 300, 220.0, 35, 0.87 0.11
 $\mu = (K_1 \cdot f_{cu} \cdot B \cdot X) \cdot \min(d - k_2 \cdot X, 0.95 \cdot d)$ $(0.4 \cdot 35 \cdot 300 \cdot 23.5) \cdot (0.95 \cdot 220.0)$ 21 kN.m
 M_{app}/μ 1.0 / 20.6 0.049 OK
 A_s Required to BS8110 Cl 3.4.4.4 Assuming $d = 231$, $d' = 69$ top 11

Shear**Max Shear**

$v_{crit} = \min(5, 0.8 \cdot \sqrt{f_{cu}})$ $\min(5, 0.8 \cdot \sqrt{35})$ 4.733 N/mm²
 $v = V_{max} / (d \cdot b)$ $5 \cdot 1000 / (220 \cdot 300)$ 0.081 N/mm² OK

Nominal Shear Zone at 320 mm

$v_c = F_n(A_s, b_v, d, f_{cu})$ 452, 300, 228, 35 0.71 N/mm² Table 3.8
 $V_{cap} = F_n(A_{sv}, S_v, b_v, d, f_{yv}, v_c)$ 101, 175, 300, 228, 500, 0.71 105.7 kN Table 3.7
 V/V_{cap} 3.0 / 105.7 0.029 OK

Nominal Shear Zone at 5867 mm

$v_c = F_n(A_s, b_v, d, f_{cu})$ 452, 300, 228, 35 0.71 N/mm² Table 3.8
 $V_{cap} = F_n(A_{sv}, S_v, b_v, d, f_{yv}, v_c)$ 101, 175, 300, 228, 500, 0.71 105.7 kN Table 3.7
 V/V_{cap} 3.0 / 105.7 0.029 OK

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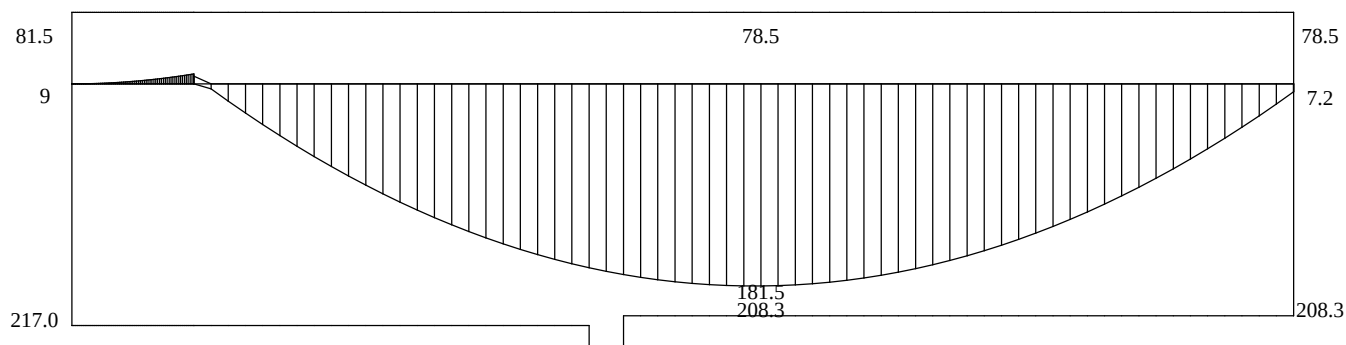
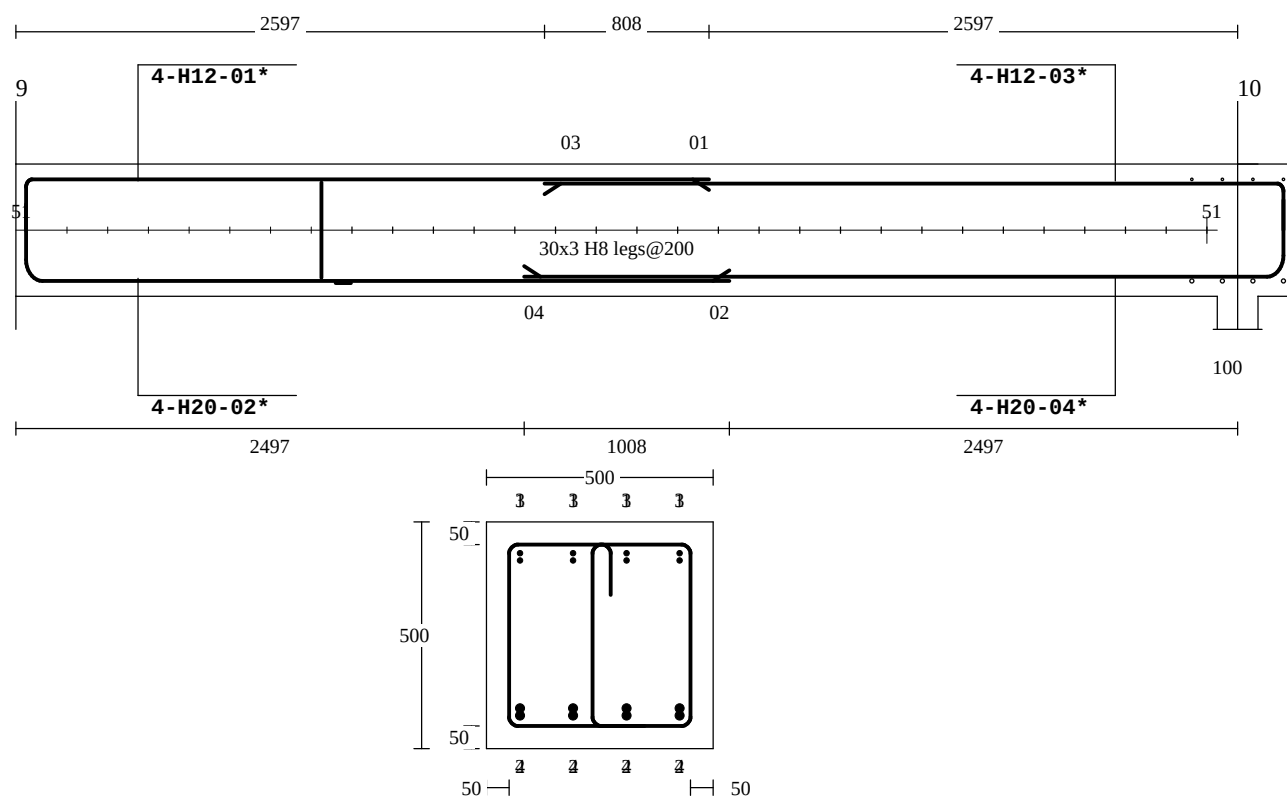
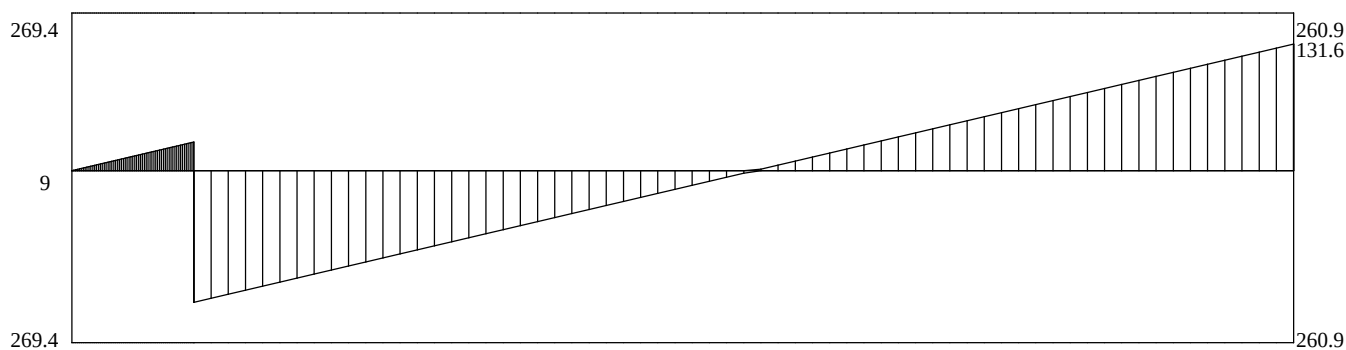
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Member CBL1Id 5 @ Level 1**Bending Moment Envelope****Shear Force Envelope**

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Member CBL1Id 5 @ Level 1**Basic Data**

Design to BS 8110: 1997
 f_{cu} , f_y , f_{yv} , v crit, K1, K2 35, 500, 500, 4.73, 0.4, 0.45

Torsional Design

Main Rectangular Section assumed to resist Torsion

T , V_{tmin} , $V_{tu(mod)}$, H_{min} , H_{max} , X_1 , Y_1 1.01, 0.40, 3.37, 500, 500, 392, 392(V_{tu} modified to Cl 2.4.5)
 $V_t = 2 \cdot T / (H_{min}^2 (H_{max} - H_{min}/3))$ $2 \times 1.01 / (500^2 \times (500 - 500/3))$ 0.02 N/mm² OK
 Combined $(V + V_t) / V_{tu(mod)} \leq 1$ $(0.634 + 0.024) / 3.373$ 0.195 OK
 $V_t < V_{tmin}$ No Special torsional reinforcement required

Bending Moments**Super-Member Hogging Peak Moment @ 599 mm. Hogging**

$X/d = F_n(A_s, f_y, K1, B_{eff}, d, f_{cu}, \gamma_m)$ 452, 500, 0.4, 500, 436.0, 35, 0.87 0.06
 $\mu = (K_1 \cdot f_{cu} \cdot B \cdot X) \cdot \min(d - k_2 \cdot X, 0.95 \cdot d)$ $(0.4 \cdot 35 \cdot 500 \cdot 28.2) \cdot (0.95 \cdot 436.0)$ 82 kN.m
 M_{app}/μ 8.9 / 81.5 0.110 OK
 A_s Required to BS8110 Cl 3.4.4.4 Assuming $d = 431$, $d' = 69$ top 50

In-Span Steel @ 3385 mm. Sagging

$X/d = F_n(A_s, f_y, K1, B_{eff}, d, f_{cu}, \gamma_m)$ 1257, 500, 0.4, 500, 416.0, 35, 0.87 0.19
 $\mu = (K_1 \cdot f_{cu} \cdot B \cdot X) \cdot \min(d - k_2 \cdot X, 0.95 \cdot d)$ $(0.4 \cdot 35 \cdot 500 \cdot 78.2) \cdot (416.0 - 0.4 \cdot 78.2)$ 208 kN.m
 M_{app}/μ 181.5 / 208.3 0.871 OK
 A_s Required to BS8110 Cl 3.4.4.4 Assuming $d = 431$, $d' = 69$ bottom 1038 mm²

Right Support Steel Sagging

$X/d = F_n(A_s, f_y, K1, B_{eff}, d, f_{cu}, \gamma_m)$ 1257, 500, 0.4, 500, 416.0, 35, 0.87 0.19
 $\mu = (K_1 \cdot f_{cu} \cdot B \cdot X) \cdot \min(d - k_2 \cdot X, 0.95 \cdot d)$ $(0.4 \cdot 35 \cdot 500 \cdot 78.2) \cdot (416.0 - 0.4 \cdot 78.2)$ 208 kN.m
 M_{app}/μ 7.2 / 208.3 0.035 OK
 A_s Required to BS8110 Cl 3.4.4.4 Assuming $d = 431$, $d' = 69$ bottom 40 mm²

Shear**Max Shear**

$v_{crit} = \min(5, 0.8 \cdot \sqrt{f_{cu}})$ $\min(5, 0.8 \cdot \sqrt{35})$ 4.733 N/mm²
 $v = V_{max} / (d \cdot b)$ $137 \cdot 1000 / (420 \cdot 500)$ 0.652 N/mm² OK

Shear Simplified approach compliance

Left Support High Shear change with in 2d of support Enhancement Ignored

Nominal Shear Zone at 1 mm

$v_c = F_n(A_s, b_v, d, f_{cu})$ 1257, 500, 432, 35 0.59 N/mm² Table 3.8
 $V_{cap} = F_n(A_{sv}, S_v, b_v, d, f_{yv}, v_c)$ 151, 200, 500, 432, 500, 0.59 269.4 kN Table 3.7
 V/V_{cap} 0.1/ 269.4 0.000 OK

Nominal Shear Zone at 5486 mm

$v_c = F_n(A_s, b_v, d, f_{cu})$ 1257, 500, 416, 35 0.6 N/mm² Table 3.8
 $V_{cap} = F_n(A_{sv}, S_v, b_v, d, f_{yv}, v_c)$ 151, 200, 500, 416, 500, 0.6 260.9 kN Table 3.7
 V/V_{cap} 106.0/ 260.9 0.406 OK

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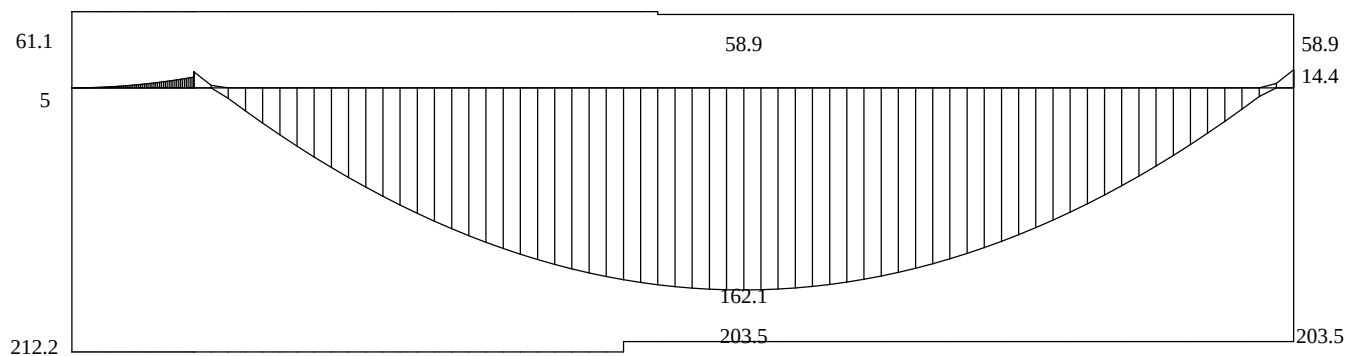
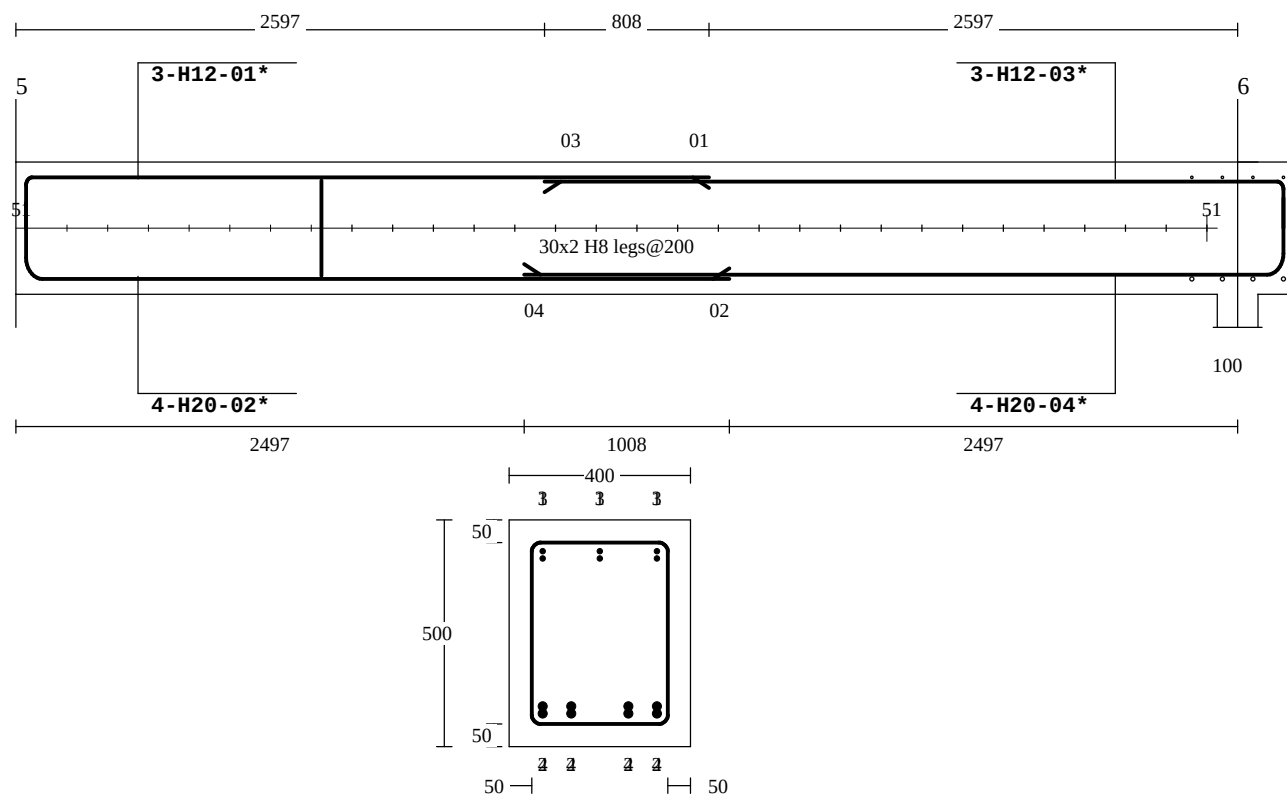
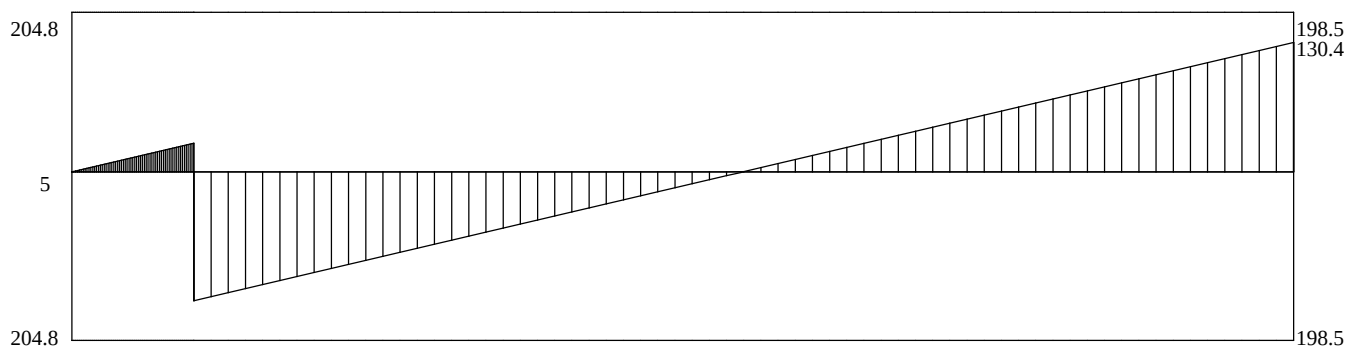
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Member CBL1Id 3 @ Level 1**Bending Moment Envelope****Shear Force Envelope**

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Member CBL1Id 3 @ Level 1**Basic Data**

Design to BS 8110: 1997
 f_{cu} , f_y , f_{yv} , v crit, K1, K2 35, 500, 500, 4.73, 0.4, 0.45

Bending Moments**Super-Member Hogging Peak Moment @ 6002 mm. Hogging**

$X/d = F_n(A_s, f_y, K1, B_{eff}, d, f_{cu}, \gamma_m)$ 339, 500, 0.4, 400, 420.0, 35, 0.87 0.06
 $\mu = (K_1 \cdot f_{cu} \cdot B \cdot X) \cdot \min(d - k_2 \cdot X, 0.95 \cdot d)$ (0.4 • 35 • 400 • 26.4) • (0.95 • 420.0) 59 kN.m
 M_{app}/μ 14.4 / 58.9 0.244 OK
 A_s Required to BS8110 Cl 3.4.4.4 Assuming $d = 431$, $d' = 69$ top 81

In-Span Steel @ 3301 mm. Sagging

$X/d = F_n(A_s, f_y, K1, B_{eff}, d, f_{cu}, \gamma_m)$ 1257, 500, 0.4, 400, 416.0, 35, 0.87 0.24
 $\mu = (K_1 \cdot f_{cu} \cdot B \cdot X) \cdot \min(d - k_2 \cdot X, 0.95 \cdot d)$ (0.4 • 35 • 400 • 97.8) • (416.0 - 0.4 • 97.8) 203 kN.m
 M_{app}/μ 162.1 / 203.5 0.797 OK
 A_s Required to BS8110 Cl 3.4.4.4 Assuming $d = 431$, $d' = 69$ bottom 935 mm²

Right Support Steel Hogging

$X/d = F_n(A_s, f_y, K1, B_{eff}, d, f_{cu}, \gamma_m)$ 339, 500, 0.4, 400, 420.0, 35, 0.87 0.06
 $\mu = (K_1 \cdot f_{cu} \cdot B \cdot X) \cdot \min(d - k_2 \cdot X, 0.95 \cdot d)$ (0.4 • 35 • 400 • 26.4) • (0.95 • 420.0) 59 kN.m
 M_{app}/μ 14.4 / 58.9 0.244 OK
 A_s Required to BS8110 Cl 3.4.4.4 Assuming $d = 431$, $d' = 69$ top 81

Shear**Max Shear**

$v_{crit} = \min(5, 0.8 \cdot \sqrt{f_{cu}})$ $\min(5, 0.8 \cdot \sqrt{35})$ 4.733 N/mm²
 $v = V_{max} / (d \cdot b)$ $130 \cdot 1000 / (420 \cdot 400)$ 0.773 N/mm² OK

Shear Simplified approach compliance

Left Support High Shear change with in 2d of support Enhancement Ignored

Nominal Shear Zone at 1 mm

$v_c = F_n(A_s, b_v, d, f_{cu})$ 1257, 400, 432, 35 0.64 N/mm² Table 3.8
 $V_{cap} = F_n(A_{sv}, S_v, b_v, d, f_{yv}, v_c)$ 101, 200, 400, 432, 500, 0.64 204.8 kN Table 3.7
 V/V_{cap} 0.1/ 204.8 0.000 OK

Nominal Shear Zone at 5486 mm

$v_c = F_n(A_s, b_v, d, f_{cu})$ 1257, 400, 416, 35 0.64 N/mm² Table 3.8
 $V_{cap} = F_n(A_{sv}, S_v, b_v, d, f_{yv}, v_c)$ 101, 200, 400, 416, 500, 0.64 198.5 kN Table 3.7
 V/V_{cap} 105.6/ 198.5 0.532 OK

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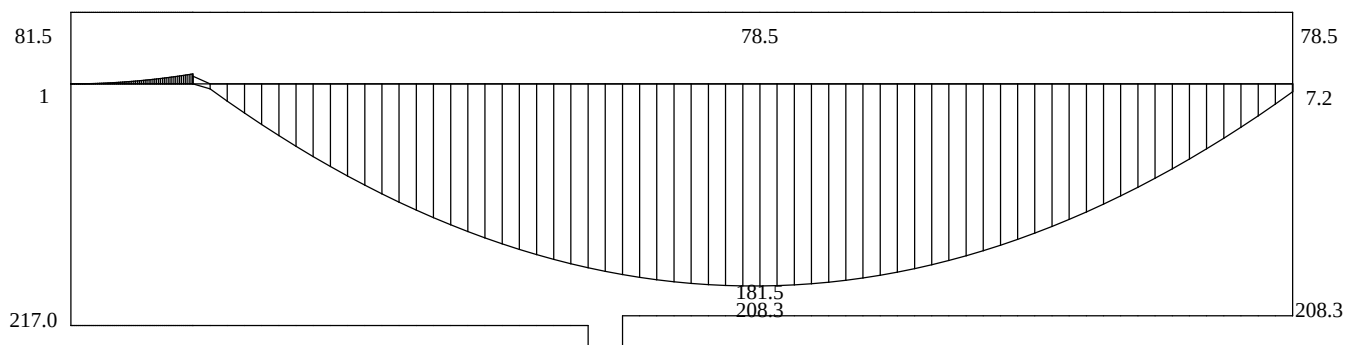
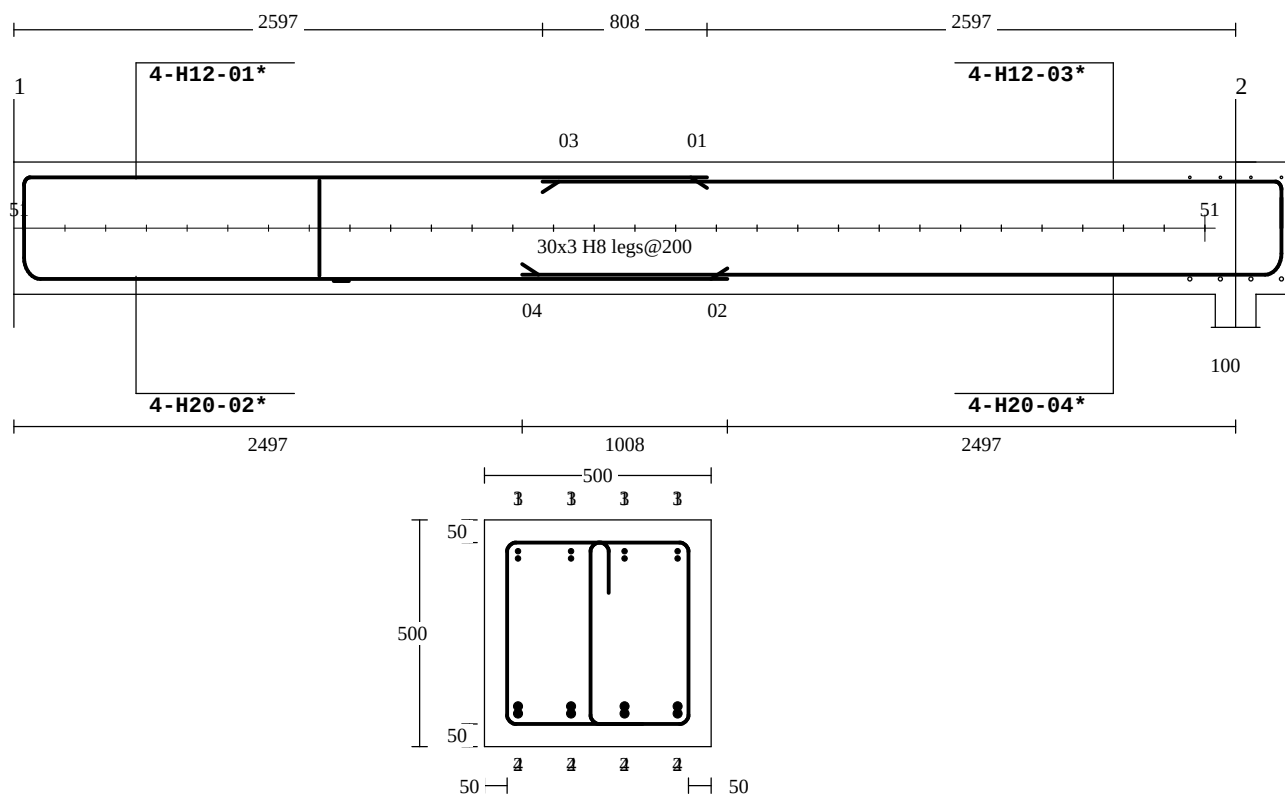
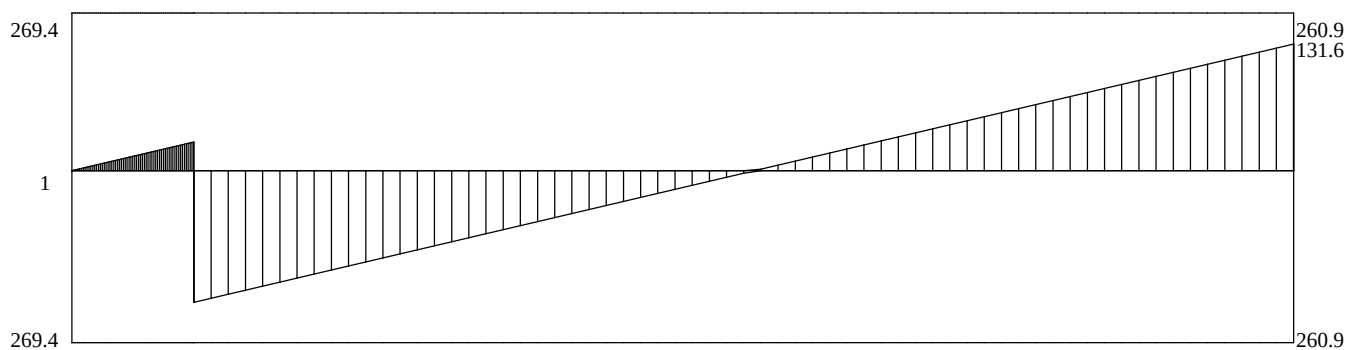
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Member CBL1Id 1 @ Level 1**Bending Moment Envelope****Shear Force Envelope**

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Member CBL1Id 1 @ Level 1**Basic Data**

Design to BS 8110: 1997
 f_{cu} , f_y , f_{yv} , v crit, K1, K2 35, 500, 500, 4.73, 0.4, 0.45

Torsional Design

Main Rectangular Section assumed to resist Torsion

T , V_{tmin} , $V_{tu(mod)}$, H_{min} , H_{max} , X_1 , Y_1 1.01, 0.40, 3.37, 500, 500, 392, 392(V_{tu} modified to Cl 2.4.5)
 $V_t = 2 \cdot T / (H_{min}^2 (H_{max} - H_{min}/3))$ $2 \times 1.01 / (500^2 \times (500 - 500/3))$ 0.02 N/mm² OK
 Combined $(V + V_t) / V_{tu(mod)} \leq 1$ $(0.634 + 0.024) / 3.373$ 0.195 OK
 $V_t < V_{tmin}$ No Special torsional reinforcement required

Bending Moments**Super-Member Hogging Peak Moment @ 599 mm. Hogging**

$X/d = F_n(A_s, f_y, K1, B_{eff}, d, f_{cu}, \gamma_m)$ 452, 500, 0.4, 500, 436.0, 35, 0.87 0.06
 $\mu = (K_1 \cdot f_{cu} \cdot B \cdot X) \cdot \min(d - k_2 \cdot X, 0.95 \cdot d)$ $(0.4 \cdot 35 \cdot 500 \cdot 28.2) \cdot (0.95 \cdot 436.0)$ 82 kN.m
 M_{app}/μ 8.9 / 81.5 0.110 OK
 A_s Required to BS8110 Cl 3.4.4.4 Assuming $d = 431$, $d' = 69$ top 50

In-Span Steel @ 3385 mm. Sagging

$X/d = F_n(A_s, f_y, K1, B_{eff}, d, f_{cu}, \gamma_m)$ 1257, 500, 0.4, 500, 416.0, 35, 0.87 0.19
 $\mu = (K_1 \cdot f_{cu} \cdot B \cdot X) \cdot \min(d - k_2 \cdot X, 0.95 \cdot d)$ $(0.4 \cdot 35 \cdot 500 \cdot 78.2) \cdot (416.0 - 0.4 \cdot 78.2)$ 208 kN.m
 M_{app}/μ 181.5 / 208.3 0.871 OK
 A_s Required to BS8110 Cl 3.4.4.4 Assuming $d = 431$, $d' = 69$ bottom 1038 mm²

Right Support Steel Sagging

$X/d = F_n(A_s, f_y, K1, B_{eff}, d, f_{cu}, \gamma_m)$ 1257, 500, 0.4, 500, 416.0, 35, 0.87 0.19
 $\mu = (K_1 \cdot f_{cu} \cdot B \cdot X) \cdot \min(d - k_2 \cdot X, 0.95 \cdot d)$ $(0.4 \cdot 35 \cdot 500 \cdot 78.2) \cdot (416.0 - 0.4 \cdot 78.2)$ 208 kN.m
 M_{app}/μ 7.2 / 208.3 0.035 OK
 A_s Required to BS8110 Cl 3.4.4.4 Assuming $d = 431$, $d' = 69$ bottom 40 mm²

Shear**Max Shear**

$v_{crit} = \min(5, 0.8 \cdot \sqrt{f_{cu}})$ $\min(5, 0.8 \cdot \sqrt{35})$ 4.733 N/mm²
 $v = V_{max} / (d \cdot b)$ $137 \cdot 1000 / (420 \cdot 500)$ 0.652 N/mm² OK

Shear Simplified approach compliance

Left Support High Shear change with in 2d of support Enhancement Ignored

Nominal Shear Zone at 1 mm

$v_c = F_n(A_s, b_v, d, f_{cu})$ 1257, 500, 432, 35 0.59 N/mm² Table 3.8
 $V_{cap} = F_n(A_{sv}, S_v, b_v, d, f_{yv}, v_c)$ 151, 200, 500, 432, 500, 0.59 269.4 kN Table 3.7
 V/V_{cap} 0.1/ 269.4 0.000 OK

Nominal Shear Zone at 5486 mm

$v_c = F_n(A_s, b_v, d, f_{cu})$ 1257, 500, 416, 35 0.6 N/mm² Table 3.8
 $V_{cap} = F_n(A_{sv}, S_v, b_v, d, f_{yv}, v_c)$ 151, 200, 500, 416, 500, 0.6 260.9 kN Table 3.7
 V/V_{cap} 106.0/ 260.9 0.406 OK