



2.4 m Hoarding Design

for

BAM Construction

at

The Embankment, Manchester (125/188)

The following spreadsheet calculates out the wind force in cities all over the UK. It will also calculate out the over-turning moment and which of the Generic Hoarding Designs will resist this over-turning moment. Codes used for these calculations were BS EN 1991 - 1 - 4:2005

See RDG drawings: 5164-03-02-001 to 5164-03-02-017

Wind Pressure Calculation

Location	Manchester			
Peak Velocity Pressure				
Fundamental basic wind speed velocity	V _{b,map}		22.50	m/s
Distance upwind to shoreline	L _{shore}		51.00	km
Altitude above sea level	A _{alt}		32.00	m
Direction factor	C _{dir}	240	1.00	
Season factor	C _{season}		1.00	
Shape parameter for probability factor	K		0.20	
Exponent for probability factor	n		0.50	
Annual probability of exceedance	p		0.02	
Altitude factor	C _{alt}		1.03	
Probability factor	C _{prob}		1.00	
Basic Wind Velocity	V _b		23.22	m/s
Basic Wind Velocity Pressure	q _b		0.331	kN/m ²
Exposure Factor	C _e (z)		1.51	
Town factor	C _{e,T}		0.68	
Peak Velocity Pressure	q _p (z)		0.34	kN/m ²
Temporary Structure Factor		0.8	0.27	kN/m ²

Wind pressure on Surfaces				
Pressure Coefficient, Zone A	$C_{p,net,a}$		2.1	
Pressure Coefficient, Zone B	$C_{p,net,b}$		1.8	
Pressure Coefficient, Zone C	$C_{p,net,c}$		1.4	
Pressure Coefficient, Zone D	$C_{p,net,d}$		1.2	
Wind pressure in Zone A	$W_{e,a}$		0.57	kN/m ²
Wind pressure in Zone B	$W_{e,b}$		0.49	kN/m ²
Wind pressure in Zone C	$W_{e,c}$		0.38	kN/m ²
Wind pressure in Zone D	$W_{e,d}$		0.33	kN/m ²

Hoarding with return corners

Figure NA.1 Value of fundamental basic wind velocity $v_{b,map}$ (m/s) before the altitude correction is applied

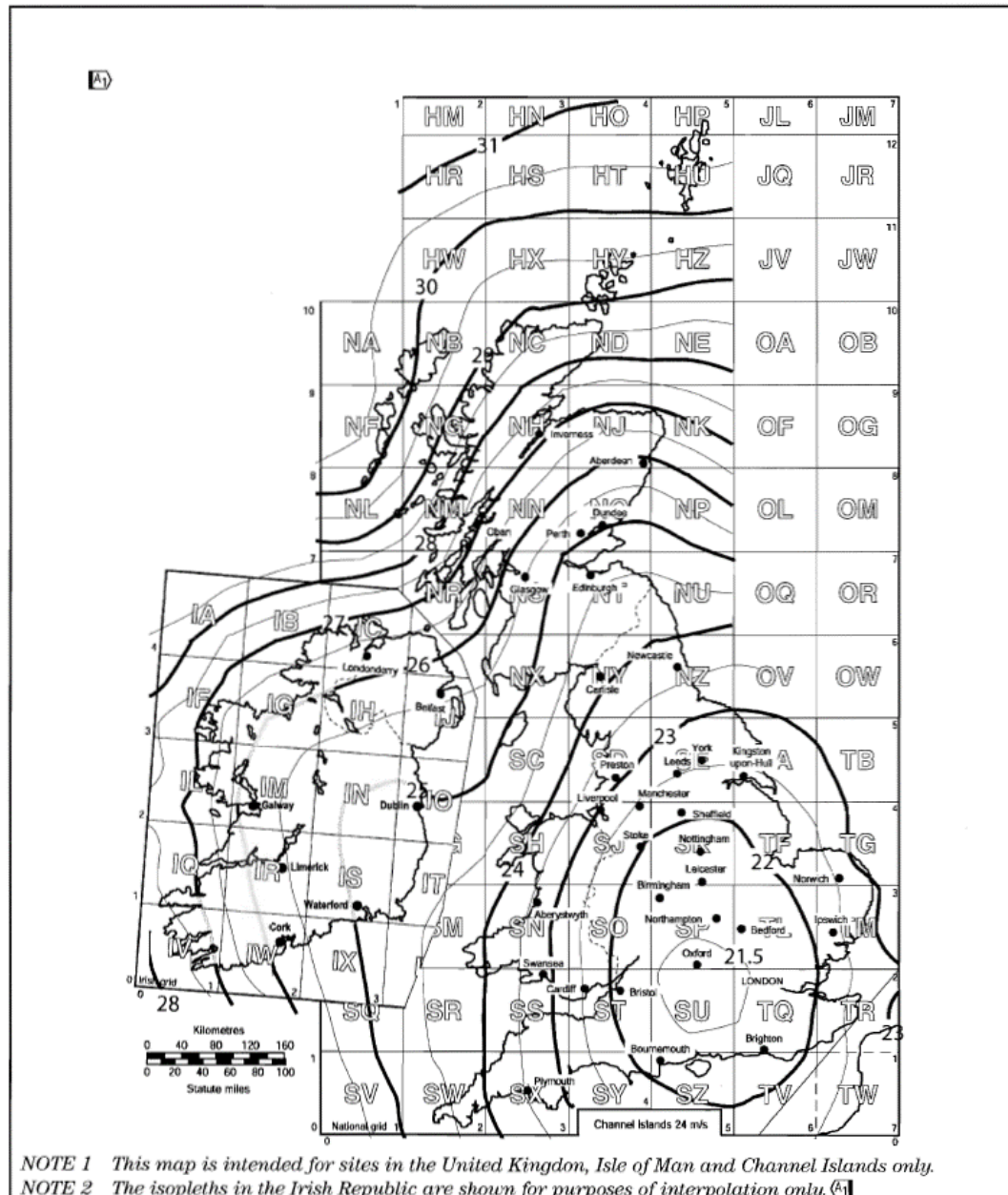


Table NA.1 Directional factor c_{dir}

Direction	0°	30°	60°	90°	120°	150°	180°	210°	240°	270°	300°	330°
c_{dir}	0,78	0,73	0,73	0,74	0,73	0,80	0,85	0,93	1,00	0,99	0,91	0,82

NOTE 1 Interpolation may be used within Table NA.1.

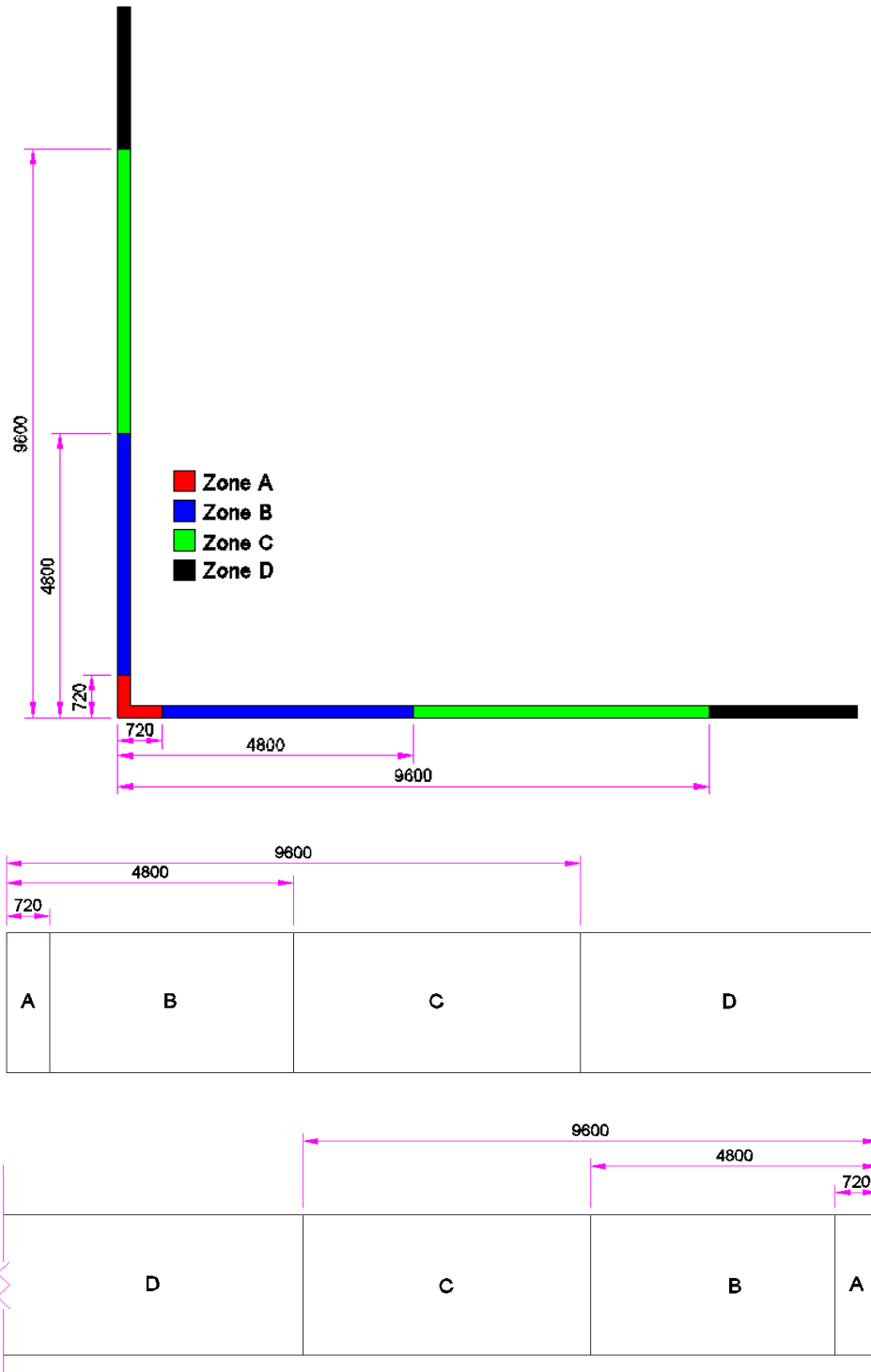
NOTE 2 The directions are defined by angles from due North in a clockwise direction.

NOTE 3 Where the wind loading on a building is assessed only for orthogonal load cases, the maximum value of the factor for the directions that lie $\pm 45^\circ$ either side of the normal to the face of the building is to be used.

NOTE 4 Conservatively, c_{dir} may be taken as 1,0 for all directions.

The following are the dimensions for the wind pressure zones. Due to the way the wind interacts with free standing walls, the wind is strongest at a return corner. The zone dimensions are tied to the height of the structure, which in this case is 2.4m (Hoardtek panels).

Height of Hoardtek Paneling	h	2.40	m
Zone A Length (See sketch)	L_a	0.72	m
Zone B Length (See sketch)	L_b	4.80	m
Zone C Length (See sketch)	L_c	9.60	m



Centres (m) **0.72 m**

Area (m²) 2.4m x 0.72 m = **1.73 m²**

Over Turning Moment (kNm) **1.18 kNm**
(Calculated taking the area of zone A)

Restoring Moment (kNm):

Concrete Block

Depth: 0.45 m
Width: 0.6 m
Length: 1.2 m
Volume of Concrete Block 0.324 m³
Density of Concrete 24 kN/m³
Total Weight of Concrete Blocks 7.776 kN
Number of blocks 1 blocks
Total weight 7.776 kN

Weight of Scaffold Frame
Length of Raker Tube 1.961 m
Length of Horizontal Fixing Tube 0.82 m
Length of Purlin Lace Tubes 0.72 m
Length of Frame Upright 2.4 m
Total Length Imposed onto Block 7.34 m
Weight of Scaffold Tube 32.08 kg
Number of Fittings Used 6 -
Total Weight of Fittings 10.8 kg
Total Self-Weight of Frame 0.42 kN

Stabilising Force from Blocks 8.20 kN
Offset to Anchor 0.3 m

Restoring Moment (kNm) = 8.20 kN x 0.3 m = **2.46 kNm**

Factor of Safety = 2.46 kNm / 1.18 kNm = **2.08**

Minimum required Factor of Safety = 1.2 Therefore: **Spacing OKAY**

Centres (m) **1.50 m**

Area (m²) 2.4m x 1.50 m = **3.60 m²**

Over Turning Moment (kNm) **2.11 kNm**

(Calculated by multiplying Zone B by area)

Restoring Moment (kNm):

Concrete Block

Depth:	0.45 m
Width:	0.6 m
Length:	1.2 m
Volume of Concrete Block	0.324 m ³
Density of Concrete	24 kN/m ³
Total Weight of Concrete Blocks	7.776 kN
Number of blocks	1 blocks
Total weight	7.776 kN

Weight of Scaffold Frame

Length of Raker Tube	1.961 m
Length of Horizontal Fixing Tube	0.82 m
Length of Purlin Lace Tubes	1.5 m
Length of Frame Upright	2.4 m
Total Length Imposed onto Block	9.68 m
Weight of Scaffold Tube	42.31 kg
Number of Fittings Used	6 -
Total Weight of Fittings	10.8 kg
Total Self-Weight of Frame	0.52 kN

Stabilising Force from Blocks	8.30 kN
Offset to Anchor	0.3 m

Restoring Moment (kNm) = 8.30 kN x 0.3 m = **2.49 kNm**

Factor of Safety = 2.49 kNm / 2.11 kNm = **1.18**

Minimum required Factor of Safety = 1.2 Therefore: **Reduce spacing**

Centres (m) **1.75 m**

Area (m²) 2.4m x 1.75 m = **4.20 m²**

Over Turning Moment (kNm) **1.92 kNm**

(Calculated by multiplying Zone B by area)

Restoring Moment (kNm):

Concrete Block

Depth:	0.45 m
Width:	0.6 m
Length:	1.2 m
Volume of Concrete Block	0.324 m ³
Density of Concrete	24 kN/m ³
Total Weight of Concrete Blocks	7.776 kN
Number of blocks	1 blocks
Total weight	7.776 kN

Weight of Scaffold Frame

Length of Raker Tube	1.961 m
Length of Horizontal Fixing Tube	0.82 m
Length of Purlin Lace Tubes	1.75 m
Length of Frame Upright	2.4 m
Total Length Imposed onto Block	10.43 m
Weight of Scaffold Tube	45.58 kg
Number of Fittings Used	6 -
Total Weight of Fittings	10.8 kg
Total Self-Weight of Frame	0.55 kN
Stabilising Force from Blocks	8.33 kN
Offset to Anchor	0.3 m

Restoring Moment (kNm) = 8.33 kN x 0.3 m = **2.50 kNm**

Factor of Safety = 2.50 kNm / 1.92 kNm = **1.30**

Minimum required Factor of Safety = 1.2 Therefore: **Spacing OKAY**

Centres (m) **2.25 m**

Area (m²) 2.4m x 2.25 m = **5.40 m²**

Over Turning Moment (kNm) **2.11 kNm**

(Calculated by multiplying Zone B by area)

Restoring Moment (kNm):

Concrete Block

Depth:	0.45 m
Width:	0.6 m
Length:	1.2 m
Volume of Concrete Block	0.324 m ³
Density of Concrete	24 kN/m ³
Total Weight of Concrete Blocks	7.776 kN
Number of blocks	1 blocks
Total weight	7.776 kN

Weight of Scaffold Frame

Length of Raker Tube	1.961 m
Length of Horizontal Fixing Tube	0.82 m
Length of Purlin Lace Tubes	2.25 m
Length of Frame Upright	2.4 m
Total Length Imposed onto Block	11.93 m
Weight of Scaffold Tube	52.14 kg
Number of Fittings Used	6 -
Total Weight of Fittings	10.8 kg
Total Self-Weight of Frame	0.62 kN
Stabilising Force from Blocks	8.39 kN
Offset to Anchor	0.3 m

Restoring Moment (kNm) = 8.39 kN x 0.3 m = **2.52 kNm**

Factor of Safety = 2.52 kNm / 2.11 kNm = **1.19**

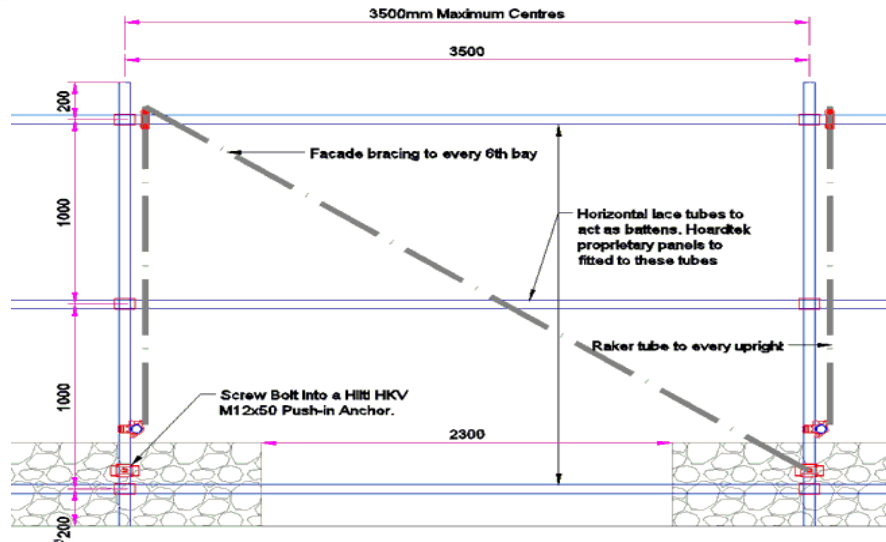
Minimum required Factor of Safety = 1.2 Therefore: **Reduce spacing**

Zone A sketch

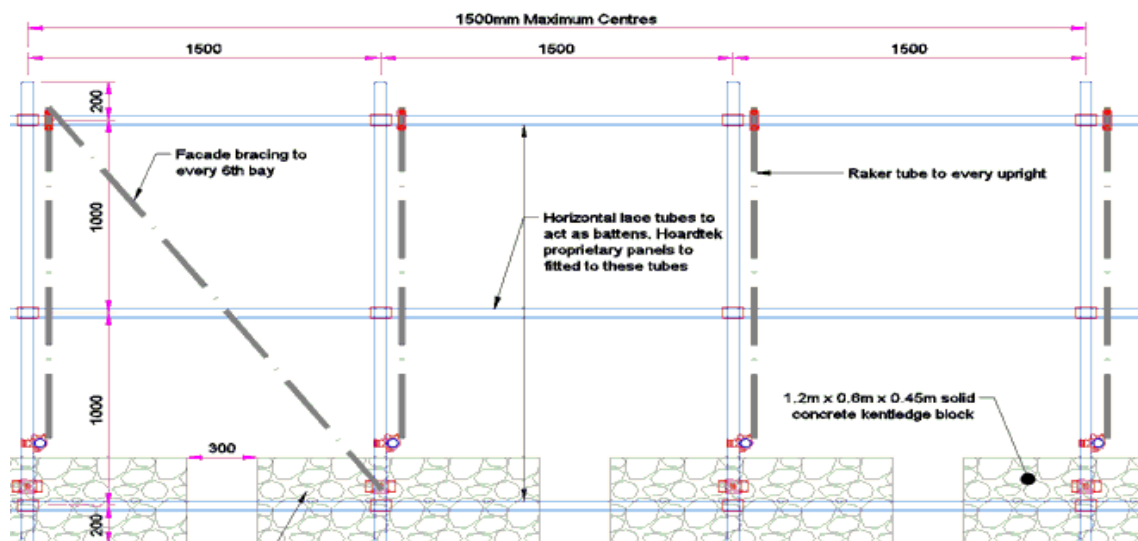
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Zone B sketch

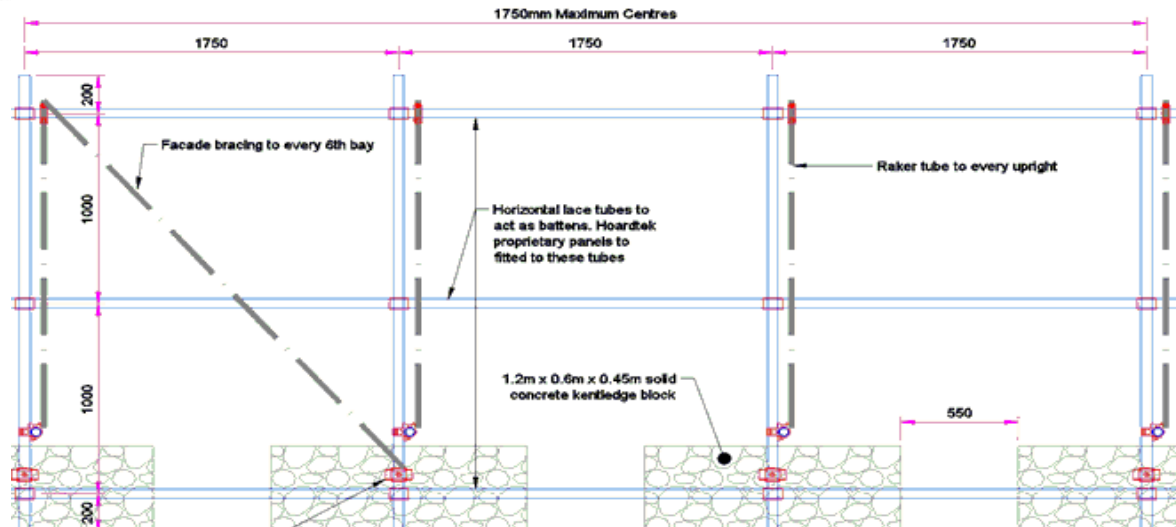


Zone C sketch

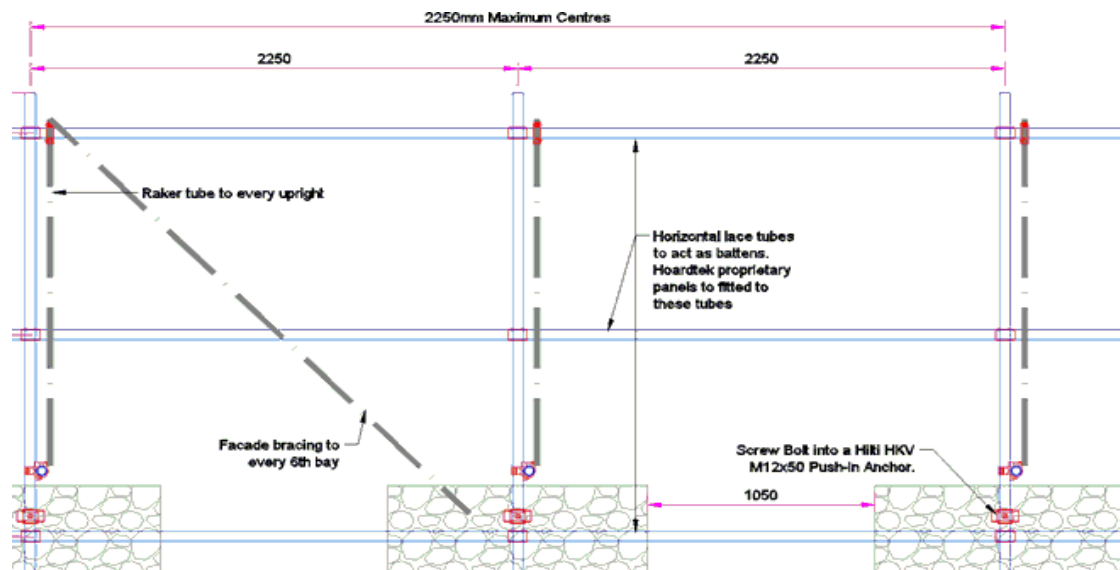
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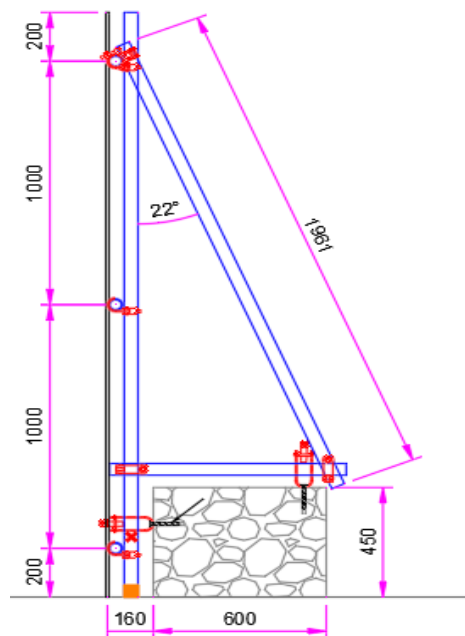
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Zone D sketch





**SECTION THROUGH THE
HOARDING STRUCTURE**

Angle of raker tube:	22 °		
Upright centres:	1.50 m		
Height of hoarding:	2.4 m		
Area:	3.6 m ²		
Wind loading:	0.49 kN/m ²		
Force acting on raker tube =	0.49 kN/m ² x	3.6 m ² =	1.76 kN
Force acting through raker tube =	1.76 kN/cos90- 22	=	4.70 kN
Length of raker tube:	1.961 m		
Effective length of raker tube:	1.961 m x 1.1 =	2.2 m	
Allowable load in rakertube:	25.3 kN	OKAY	
Connection check (force through 2 class 'b' couplers):	2 x 9.1 kN =	18.1 kN	
=>	18.1 kN	>	4.70 kN OKAY

Scaffold Batten Check - (Zone B)

Width of horizontal batten:			1.0 m	
Wind load:			0.49 kN/m ²	
UDL to batten:			0.49 kN/m	
Span of batten:			1.50 m	
Maximum bending moment:		$wL^2/8 =$	0.14 kNm	
Allowable bending moment:	1.12 kNm	>	0.14 kNm	OKAY

Scaffold Standard Check - (Zone B)

Standard Centres:			1.50 m	
Span of standard:			2.4 m	
Wind load:			0.49 kN/m ²	
UDL to standard:			0.73 kN/m	
Maximum bending moment:		$wL^2/8 =$	0.53 kNm	
Allowable bending moment:	1.12 kNm	>	0.53 kNm	OKAY

For the hoarding support frame to fully utilize the solid concrete kentledge blocks, we will rely on the anchors under shear and tensile loading into the concrete blocks.

Maximum overturning moment: 2.11 kNm

Offset for the overturning point: 0.3 m

Force to anchors: $2.11 \text{ kNm} / 0.3 \text{ m} = 7.04 \text{ kN}$

Considering the frame as a mechanism, we can assume that the force in the anchors is to be checked against the shear capacity of the anchors, as this can be considered a pure uplifting force.

Shear capacity of Hilti HKV M12x50 Anchor into concrete: 14.6 kN

Tie suitability: $14.6 \text{ kN} > 7.04$ **OKAY**

TG20:13, Design Guide, Table 5.10

Safe axial loads for permissible stress design of BS EN 39 Type 4 steel scaffold tubes, for 'As new' tubes.

Effective length L_E (m)	Slenderness Ratio (L_E/r)	Self-Weight (kg/m)	Safe Axial Load P_C^{STEEL} (kN)	Safe Axial Load P_C^{STEEL} (kN) (fixed in direction at both ends)
0.20	12.70	0.87	79.3	80.14
0.30	19.05	1.31	77.9	79.16
0.40	25.40	1.75	76.5	78.18
0.50	31.75	2.19	73.7	77.20
0.60	38.10	2.62	70.9	75.94
0.70	44.45	3.06	68.0	73.98
0.80	50.80	3.50	65.0	72.02
0.90	57.15	3.93	61.8	70.02
1.00	63.50	4.37	58.6	67.95
1.10	70.00	4.81	55.3	65.89
1.20	76.50	5.24	51.9	63.72
1.30	82.70	5.68	48.6	61.48
1.40	88.90	6.12	45.3	59.24
1.50	95.30	6.56	42.3	56.93
1.60	101.70	6.99	39.2	54.58
1.70	108.05	7.43	36.5	52.24
1.80	114.40	7.87	33.7	49.92
1.90	120.75	8.30	21.4	47.61
2.00	127.10	8.74	29.1	45.30
2.10	133.45	9.18	27.2	43.17
2.20	139.80	9.61	25.3	41.03
2.30	146.15	10.05	23.7	38.90
2.40	152.50	10.49	22.0	37.00
2.50	158.85	10.93	20.7	35.08
2.60	165.20	11.36	19.3	33.24
2.70	171.55	11.80	18.2	31.63
2.80	177.90	12.24	17.1	30.02
2.90	184.25	12.67	16.2	28.53
3.00	190.60	13.11	15.2	37.20