



Hoarding System Calculations

Project:	Manchester
Client:	PP O'Connor
Project No.:	H25.0196 v1
Date:	12 February 2025

PREPARED BY *Gregory Guppy*

PROJECT *Manchester*

Date *Feb-25*

CLIENT *PP O'Connor*

Design Philosophy

Design Code

In the context of a building project, the site hoarding is considered as part of the temporary works. On this basis, BS5975:2019 - 'Code of Practice for Temporary Works Procedures and the Permissible Stress Design of Falsework' is considered by Hoard-it as the relevant design code for hoardings.

Applied Loading - Wind

Section 17.5.1 of BS5975:2019 provides a simple method of calculating wind pressures that 'temporary works' structures can reasonably be predicted to experience.

The hoarding is modelled as a 'free standing wall'. BS5975:2019 doesn't provide all the information required to design the hoarding as a free standing wall and reference needs to be made to BS EN 1991-1-4:2005+A1:2010, on which the simple approach in BS5975:2019 is based. Section 7.4 of BS EN 1991-1-4:2005+A1:2010 provides the pressure coefficients that are required to determine the forces applied to the hoarding.

As described in BS EN 1991-1-4:2005+A1:2010, the length of the hoarding is split into four discrete areas. Each section is designed to resist a different wind pressure. The larger pressures are designed for towards the ends and corners of the hoarding. Figure 1 shows how Hoard-it splits down into the 4 No. zones.

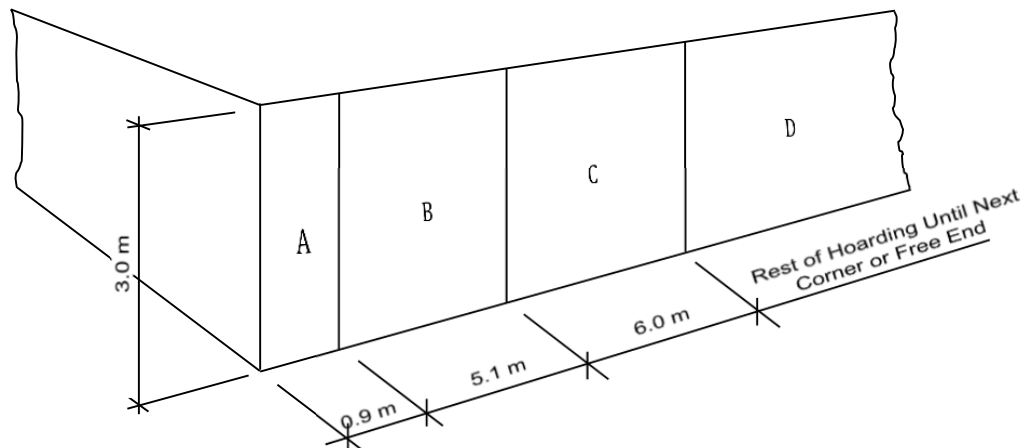


Figure 1 - Hoard-it Wind Pressure Zones

Due to the small size of Zone A and the negligible effect it has on the load applied to each post, Zone B is considered the critical zone for the purposes of these calculations.

	Calculation Sheet	Sheet No.
PREPARED BY <i>Gregory Guppy</i>		Project No. <i>H25.0196 v1</i>
Date <i>Feb-25</i>	PROJECT <i>Manchester</i> CLIENT <i>PP O'Connor</i>	

Design Philosophy

Loading Model

To allow the force on each post and block assembly to be determined, half the load from the bays either side of the post is assumed to be transferred into the post and block of interest, shown as the hatched area of figure 2.

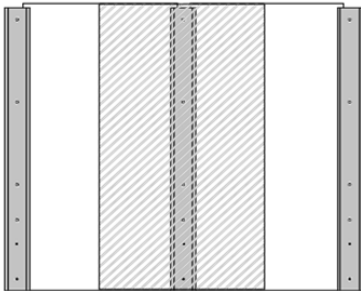


Figure 2 - Vertical Bay - Area of Effective Load for Central Post

Resistance to Wind Loading

Overturning

The overturning resistance is determined using the principle of equilibrium.

A factor of safety of 1.2 against overturning is used in design, unless specified otherwise by the Client or in the opinion of hoard-it is dictated by specific site conditions.

Sliding

The sliding resistance is determined by multiplying the total weight of each bay (including posts and boards) by the appropriate coefficient of static friction, obtained from BS5975:2019.

Normally, using a F.o.S. of 1.2, in line with that used for overturning is seen as a sensible approach. However, a greater factor of safety may be used where specified by the Client or if, in the opinion of hoard-it, is dictated by specific site conditions.

Plywood Board

The plywood board design is based on the permissible stress design philosophy, as specified in BS5975:2019.

Steel Post

The steel post design is based on the permissible stress design philosophy, as specified in BS5975:2019.

		Calculation Sheet	Sheet No. Project No. H25.0196 v1
PREPARED BY <i>Gregory Guppy</i>	PROJECT <i>Manchester</i>		
Date <i>Feb-25</i>	CLIENT <i>PP O'Connor</i>		

Hoard-it Configuration Options 3m system

Option 1 Return End - No Crowd

Zone B Solid 750kg Block Vertical	Zone C Solid 750kg Block Vertical	Zone D Solid 473+kg Block Vertical 3 Additional 28kg Blocks per Hoard-it Block Required
---	---	--

Note! Doubled Up Posts Required

Option 2 Return End - With Crowd

Zone B	Zone C	Zone D
---------------	---------------	---------------

Option 3 Free End - No Crowd

Zone B Solid - every other board 0.71 spacings 750kg Block Vertical	Zone C Solid 750kg Block Vertical	Zone D Solid 473+kg Block Vertical 3 Additional 28kg Blocks per Hoard-it Block Required
---	---	--

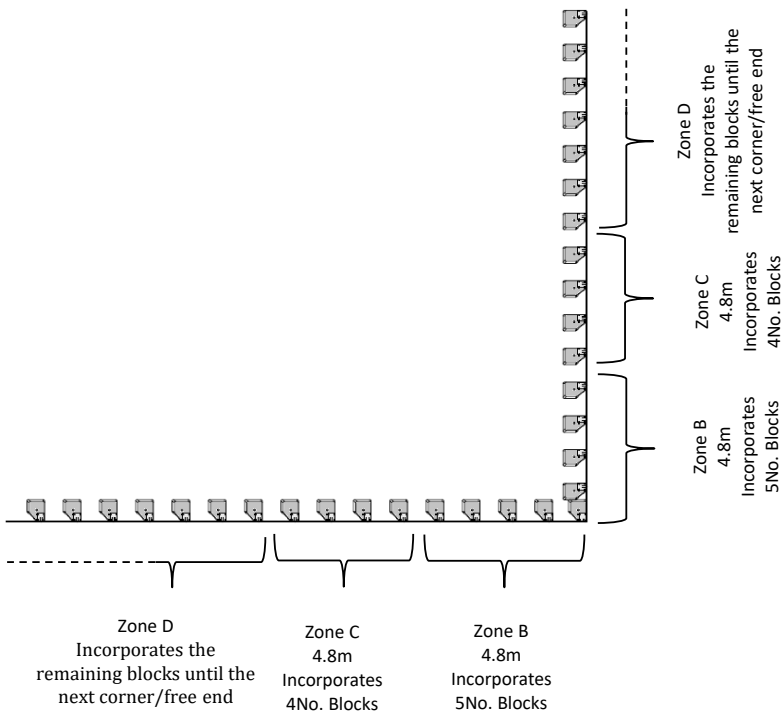
Note! Doubled Up Posts Required Note! Doubled Up Posts Required

Option 4 Free End - With Crowd

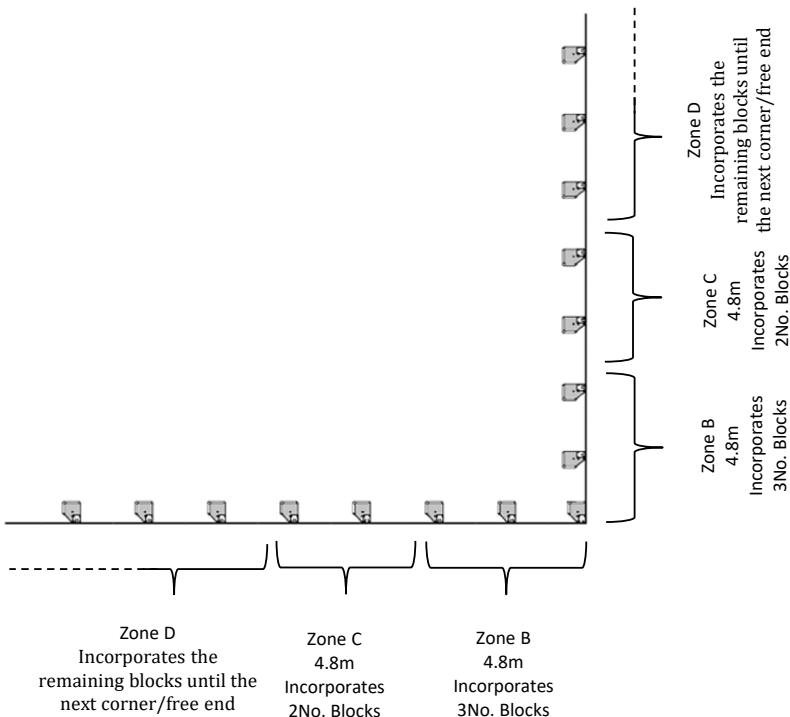
Zone B	Zone C	Zone D
---------------	---------------	---------------

Additional Ballast Layout

Vertical System



Horizontal System



PREPARED BY *Gregory Guppy*PROJECT *Manchester*Date *Feb-25*CLIENT *PP O'Connor*

Site Location

● Site Location
M4 7DB





Calculation Sheet

Sheet No.

Project No. H25.0196 v1

PREPARED BY *Gregory Guppy*PROJECT *Manchester*Date *Feb-25*CLIENT *PP O'Connor*

Calculation of Peak Velocity Pressure to BS5975:2019 - Direction 1

Site Details

Location: *Manchester*
Post Code: *M4 7DB*
Site Altitude: *53 m*
Basic Wind Velocity, $v_{b,map}$: *22.45 m/s*
Terrain: *Town*
Min Dist to Sea: *57.9 km*

Design Details

C_{ef} : *1.207*
 T_{wind} : *1.0*
 H : *3.0 m*
 $h_{effective} (z-h_{dis})$: *3.0 m*
 C_{dir} : *1.00* *(Considering wind from most onerous direction)*
 C_{season} : *1.00*
 C_{prob} : *0.83* *(Based on hoarding being on site for maximum 2 years)*
 S_{wind} : *23.6 m/s*

Peak Velocity Pressure, q_p

Peak Velocity Pressure, q_p : *0.285 kN/m²*

(Gust Wind Speed: *22 m/s* *(48 mph)*)



Calculation Sheet

Sheet No.

Project No. H25.0196 v1

PREPARED BY *Gregory Guppy*PROJECT *Manchester*Date *Feb-25*CLIENT *PP O'Connor*

Calculation of Peak Velocity Pressure to BS5975:2019 - Direction 2

Site Details

Location: *Manchester*
Post Code: *M4 7DB*
Site Altitude: *53 m*
Basic Wind Velocity, $v_{b,map}$: *22.45 m/s*
Terrain: *Town*
Min Dist to Sea: *57.9 km*

Design Details

C_{ef} : *1.207*
 T_{wind} : *1.0*
 H : *3.0 m*
 $h_{effective} (z-h_{dis})$: *3.0 m*
 C_{dir} : *0.99*
 C_{season} : *1.00*
 C_{prob} : *0.83* *(Based on hoarding being on site for maximum 2 years)*
 S_{wind} : *23.6 m/s*

Peak Velocity Pressure, q_p

Peak Velocity Pressure, q_p : *0.279 kN/m²*

(Gust Wind Speed: *21 m/s* *(48 mph)*)



Calculation Sheet

Sheet No.

Project No. H25.0196 v1

PREPARED BY *Gregory Guppy*PROJECT *Manchester*Date *Feb-25*CLIENT *PP O'Connor*

Calculation of Peak Velocity Pressure to BS5975:2019 - Direction 3

Site Details

Location: *Manchester*
Post Code: *M4 7DB*
Site Altitude: *53 m*
Basic Wind Velocity, $v_{b,map}$: *22.45 m/s*
Terrain: *Town*
Min Dist to Sea: *141.9 km*

Design Details

C_{ef} : *1.17*
 T_{wind} : *1.0*
 H : *3.0 m*
 $h_{effective} (z-h_{dis})$: *3.0 m*
 C_{dir} : *0.78*
 C_{season} : *1.00*
 C_{prob} : *0.83* *(Based on hoarding being on site for maximum 2 years)*
 S_{wind} : *23.6 m/s*

Peak Velocity Pressure, q_p

Peak Velocity Pressure, q_p : *0.168 kN/m²*

(Gust Wind Speed: *17 m/s* (*37 mph*))



Calculation Sheet

Sheet No.

Project No. H25.0196 v1

PREPARED BY *Gregory Guppy*PROJECT *Manchester*Date *Feb-25*CLIENT *PP O'Connor*

Calculation of Peak Velocity Pressure to BS5975:2019 - Direction 4

Site Details

Location: *Manchester*
Post Code: *M4 7DB*
Site Altitude: *53 m*
Basic Wind Velocity, $v_{b,map}$: *22.45 m/s*
Terrain: *Town*
Min Dist to Sea: *151.6 km*

Design Details

C_{ef} : *1.17*
 T_{wind} : *1.0*
 H : *3.0 m*
 $h_{effective} (z-h_{dis})$: *3.0 m*
 C_{dir} : *0.85*
 C_{season} : *1.00*
 C_{prob} : *0.83* *(Based on hoarding being on site for maximum 2 years)*
 S_{wind} : *23.6 m/s*

Peak Velocity Pressure, q_p

Peak Velocity Pressure, q_p : *0.199 kN/m²*

(Gust Wind Speed: *18 m/s* *(40 mph)*)

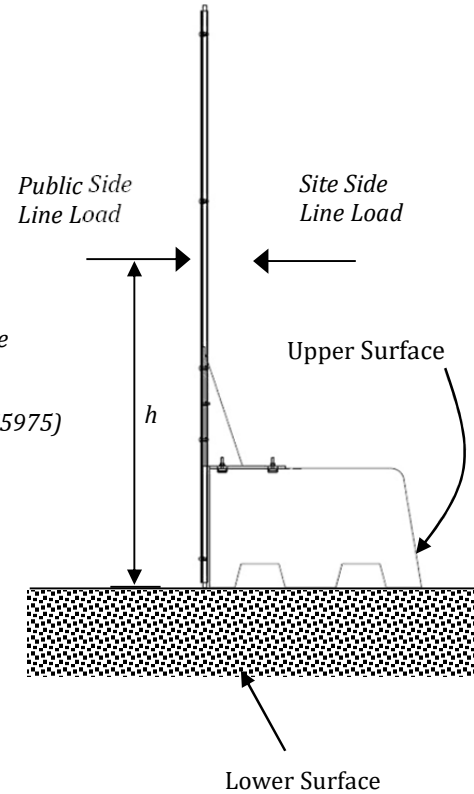
PREPARED BY *Gregory Guppy*

PROJECT *Manchester*

Date *Feb-25*

CLIENT *PP O'Connor*
Pedestrian / Crowd Loading - 1.015m System with 750kg Block
Input

Applied Line Load: *0.74 kN/m*
 Height of Load Applied, *h*: *1.1 m*
 Post Centres: *1.02 m*
 Support Block: *750kg Block*
 Factor of Safety - Overturning: *1.2*
 Factor of Safety - Sliding: *1.2*
 Upper' Surface: *Hardened Concrete - Cast Face*
 Lower' Surface: *Soil - Granular*
 Coefficient of Friction, μ : *0.4 (Refer to Table 24 of BS5975)*


System resistance

Overturning Resistance - Site Side: *4.31 kNm*
 Overturning Resistance - Public Side: *5.04 kNm*
 Mass of Assembly: *813 kg*
 Sliding Resistance: *3.25 kN*
(0.4 x 813/100)

Applied Load

Applied Overturning Moment: *0.83 kNm*
 Applied Sliding Force: *0.75 kN*

Result

Overturning - Site Side F.o.S: *5.2 > 1.2 ∴ O.K.*
 Overturning - Public Side F.o.S: *6.1 > 1.2 ∴ O.K.*
 Sliding F.o.S: *4.3 > 1.2 ∴ O.K.*



Calculation Sheet

Sheet No.

Project No.

H25.0196 v1

PREPARED BY

Gregory Guppy

PROJECT

Manchester

DATE

Feb-25

CLIENT

PP O'Connor

Overturing Check - Zone B

Design Input - Geometry

Support Block: 750kg Block

Left Hand Board: Vertical

Right Hand Board: Vertical

Design Input - Wind Loading

Peak Velocity Pressure: 0.285 kN/m^2

Pressure Zone: Zone B Without Returns

Pressure Coefficient: 2.1

Design Input - General

Required Factor of Safety: 1.20

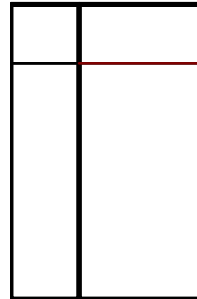
Design Check

Overturing Resistance

Overturing Resistance: 5.04 kNm

Applied Loading

Elevation of Hoarding



	LHS					RHS				
	Width = 0.71 m					Width = 1.32 m				
	Height	Solidity	Force Coeff	Force	Lever Arm	Height	Solidity	Force Coeff	Force	Lever Arm
Lower Section	2.4 m	1.00	2.1	0.51 kN	1.2 m	2.4 m	1.00	2.1	0.95 kN	1.2 m
Central Section	-	-	-	-	-	-	-	-	-	-
Upper Section	0.6 m	1.00	2.1	0.13 kN	2.7 m	0.6 m	1.00	2.1	0.24 kN	2.7 m
Overturing Moment = 0.96 kNm					Overturing Moment = 1.78 kNm					

Applied Overturing Moment: 2.73 kNm

Result

Factor of Safety: 1.84 > 1.20

∴ O.K.

PREPARED *Gregory Guppy*

PROJECT *Manchester*

Date *Feb-25*

CLIENT *PP O'Connor*

Sliding Check - Zone B

Design Input - Geometry

Support Block: *750kg Block*

Left Hand Board: *Vertical*

Right Hand Board: *Vertical*

Design Input - Wind Loading

Peak Velocity Pressure: *0.285 kN/m²*

Pressure Zone: *Zone B Without Returns*

Pressure Coefficient: *2.1*

Design Input - General

Upper' Surface: *Hardened Concrete - Cast Face*

Lower' Surface: *Soil - Granular*

Coefficient of Static Friction, m: *0.4*

Required Factor of Safety: *1.2*

Design Check

Sliding Resistance

Weight of Hoarding: *8.13 kN*

Sliding Resistance: *3.25 kN*

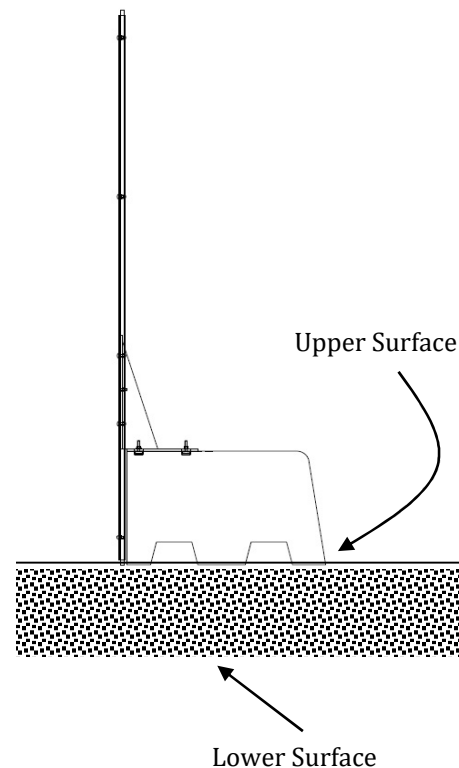
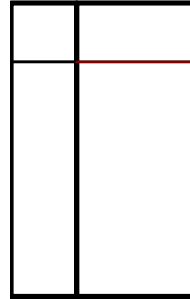
Applied Loading

Applied Wind Load: *1.82 kN*

Result

Factor of Safety: *1.78* > *1.20* ∴ *O.K.*

Elevation of Hoarding



PREPARED BY

Gregory Guppy

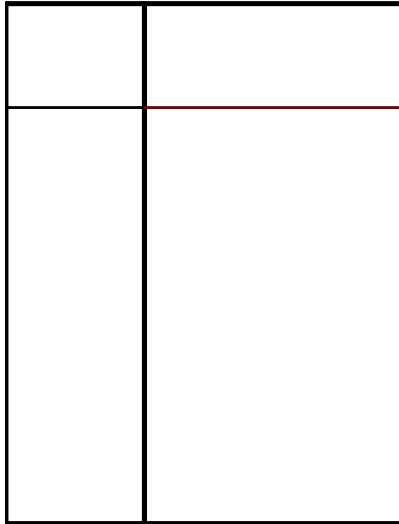
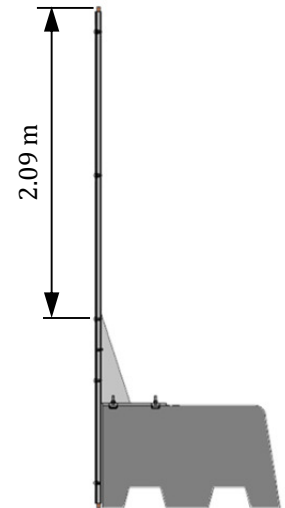
PROJECT

Manchester

DATE

Feb-25

CLIENT

PP O'Connor
Steel Post Design - to BS 449-2:1969 - Applied Loading

Elevation of Hoarding

Section Through Hoarding
Wind Loading

Peak Velocity Pressure, q_p : 0.285 kN/m^2

Pressure Zone: Zone B

Peressure Coefficient: 2.1

Loading Calculation

	LHS					RHS				
	Width = 0.71 m					Width = 1.32 m				
	Height	Solidity	Force Coeff	Force	Lever Arm	Height	Solidity	Force Coeff	Force	Lever Arm
Lower Section	1.49m	1.0	2.1	0.32kN	0.75m	1.49m	1.0	2.1	0.59kN	0.75m
Central Section	-	-	-	-	-	-	-	-	-	-
Upper Section	0.6m	1.0	2.1	0.13kN	1.79m	0.6m	1.0	2.1	0.24kN	1.79m
Moment at Base of Cantilever = 0.46 kNm						Moment at Base of Cantilever = 0.86 kNm				
Shear at Base of Cantilever = 0.44 kN						Shear at Base of Cantilever = 0.83 kN				

Applied Moment on Cantilever: 1.33 kNm

Applied Shear on Cantilever: 1.27 kN

PREPARED BY *Gregory Guppy*

PROJECT *Manchester*

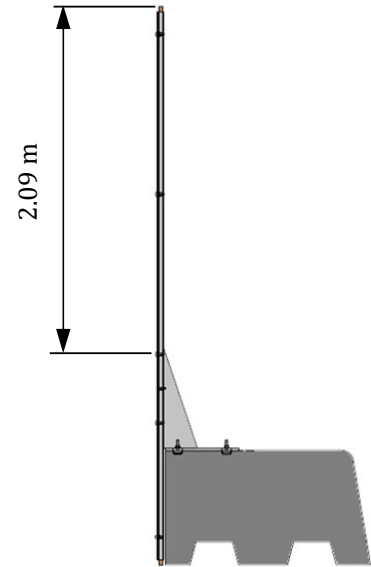
Date *Feb-25*

CLIENT *PP O'Connor*

Steel Post Design - to BS 449-2:1969

Design Input

Post Centres: 1.02 m
Block: 750kg Block
Cantilever Length: 2.09 m (Top of post to first bolt into bracket)
Steel Grade: 43 (S275)
Elastic Modulus: 6749 mm³
Shear Area: 108 mm²
Peak Velocity Pressure, q_p : 0.285 kN/m²
Pressure Zone: Zone B
Peressure Coefficient: 2.1
Include 25% Overstress: Yes (Refer to Clause 13 of BS449-2:1969)



Section Through Hoarding

Bending Check

Output

Applied UDL: 0.598 kN/m²
Applied Bending Moment: 1.33 kNm
Applied Stress, f : 197 N/mm²
Allowable Stress, p_{bc} : 180 N/mm² (From Table 2 of BS449-2:1969)
Maximum Allowable Stress, p_{bc} : 225 N/mm² (Inclusive of 25% Overstress as allowed in Clause 13 of BS449-2:1969)

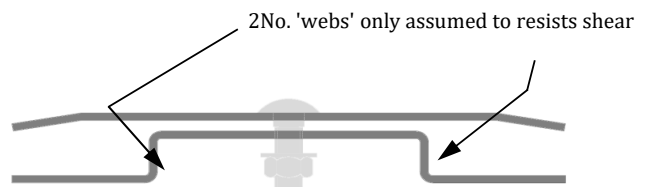
Bending Result

225 N/mm² > 197 N/mm² ∴ O.K.

Shear Check

Output

Applied UDL: 0.598 kN/m²
Maximum Shear Force: 1.27 kN
Applied Average Stress, f : 11.8 N/mm²
Allowable Stress, p_v : 110 N/mm² (From Table 11 of BS449-2:1969)
Maximum Allowable Stress, p_v : 138 N/mm² (Inclusive of 25% Overstress as allowed in Clause 13 of BS449-2:1969)



Section Through Steel Post

Shear Result

138 N/mm² > 11.8 N/mm² ∴ O.K.

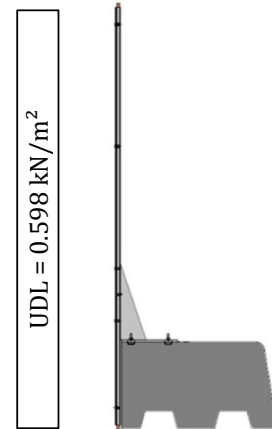
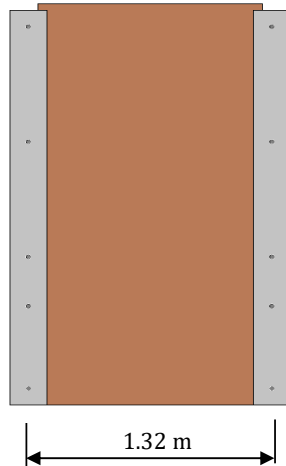
PREPARED BY *Gregory Guppy*

PROJECT *Manchester*

Date *Feb-25*

CLIENT *PP O'Connor*

Timber Board Design - to BS 5268-2:2002 - Design Parameters



Design Input

Board Orientation: *Vertical*
 Post Centres: *1.32 m*
 Block: *750kg Block*
 Peak Velocity Pressure, q_p : *0.285 kN/m²*
 Pressure Zone: *Zone B*
 Pressure Coefficient: *2.1*
 Board Width: *1220 mm*
 Grip in Boards *40 mm*

Plywood Properties

Board Description: *Finish Conifer Plywood, Thick Veneer*
 Board Thickness: *18 mm*
 Effective Thickness: *17.1 mm* *(Refer to Table 34 of BS5268-2:2002)*

Grade Stresses:

(Refer to Table 51 of BS5268-2:2002)

Bending Perpendicular to Grain: *6.39 N/mm²*
 Transverse Shear Perpendicular to Grain: *1.72 N/mm²*
 Rolling Shear: *0.44 N/mm²*
 Bearing on Face: *1.88 N/mm²*
 Modulus of Elasticity (Perpendicular to Grain): *1915 N/mm²*

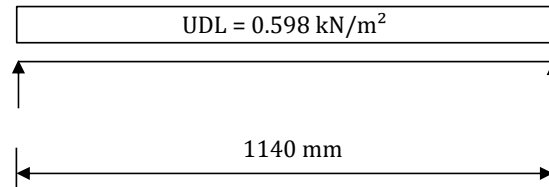
PREPARED BY *Gregory Guppy*

PROJECT *Manchester*

Date *Feb-25*

CLIENT *PP O'Connor*
Timber Board Design - to BS 5268-2:2002 - Board Bending

Loading Diagram



BMD


Bending Check - Allowable Stress

K_{36} : 1.17 (Short Term and Service Class 3 - Refer to Table 39 of BS5268-2:2002)

Permissible Stress: 7.48 N/mm²

Bending Check - Applied Stress

Applied UDL: 0.598 kN/m²

Beam Span: 1140 mm

Applied Bending Moment: 0.097 kNm/m

Section Modulus: 48735 mm³/m

Maximum Applied Stress: 1.99 N/mm²

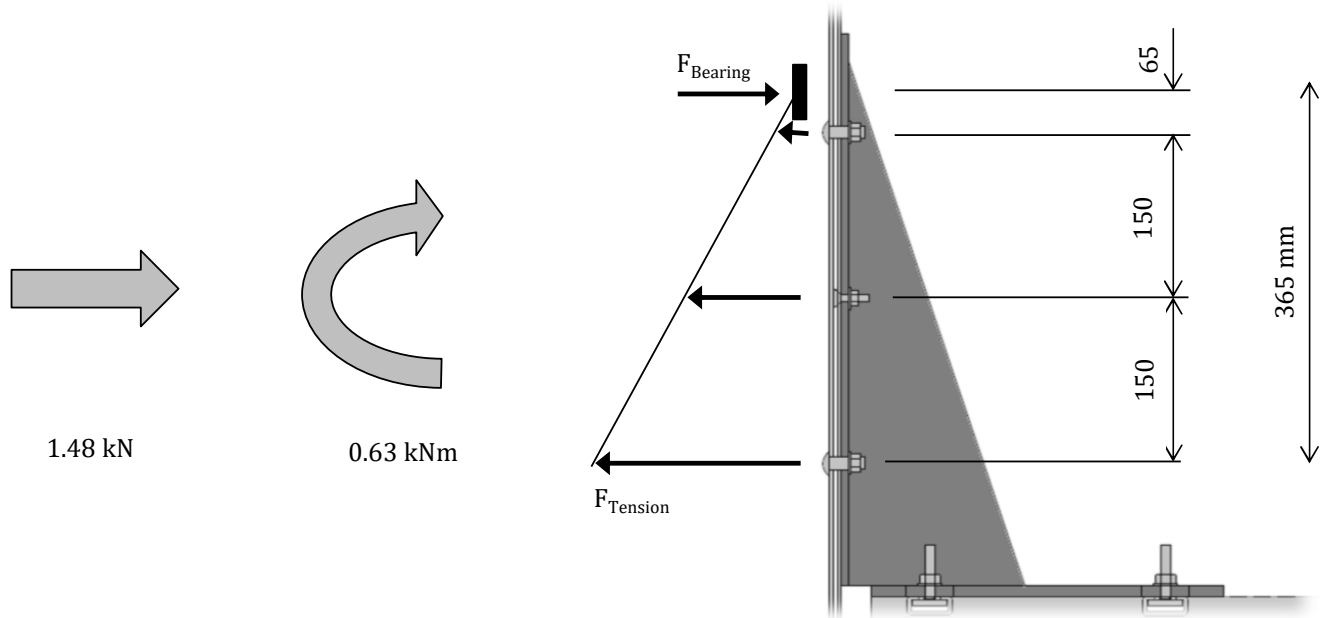
Bending Result

7.5 N/mm² > 2.0 N/mm² ∴ O.K.

PREPARED BY *Gregory Guppy*

PROJECT *Manchester*

Date *Feb-25*

CLIENT *PP O'Connor*
Steel Post to Bracket Connection - to BS 449-2:1969

Design Input

Post Centres:	1.02 m	
Block:	750kg Block	
Steel Grade:	43	(S275)
Peak Velocity Pressure, q_p :	0.285 kN/m ²	
Pressure Zone:	Zone B	
Pressure Coefficient:	2.1	
Include 25% Overstress:	Yes	(Refer to Clause 13 of BS449-2:1969)
Bearing Length:	20 mm	
Lever Arm:	365 mm	
Applied Moment @ Connection:	0.63 kNm	
Design Moment @ Connection:	0.37 kNm	$(0.63 - 1.48 \times 0.365/2)$
Effective Lever Arm:	503 mm	
Max Bolt Tension:	0.73 kN	$(0.37/0.503)$
Bearing Force:	2.76 kN	(Sum of Bolt Tensions + Applied Lateral Load)

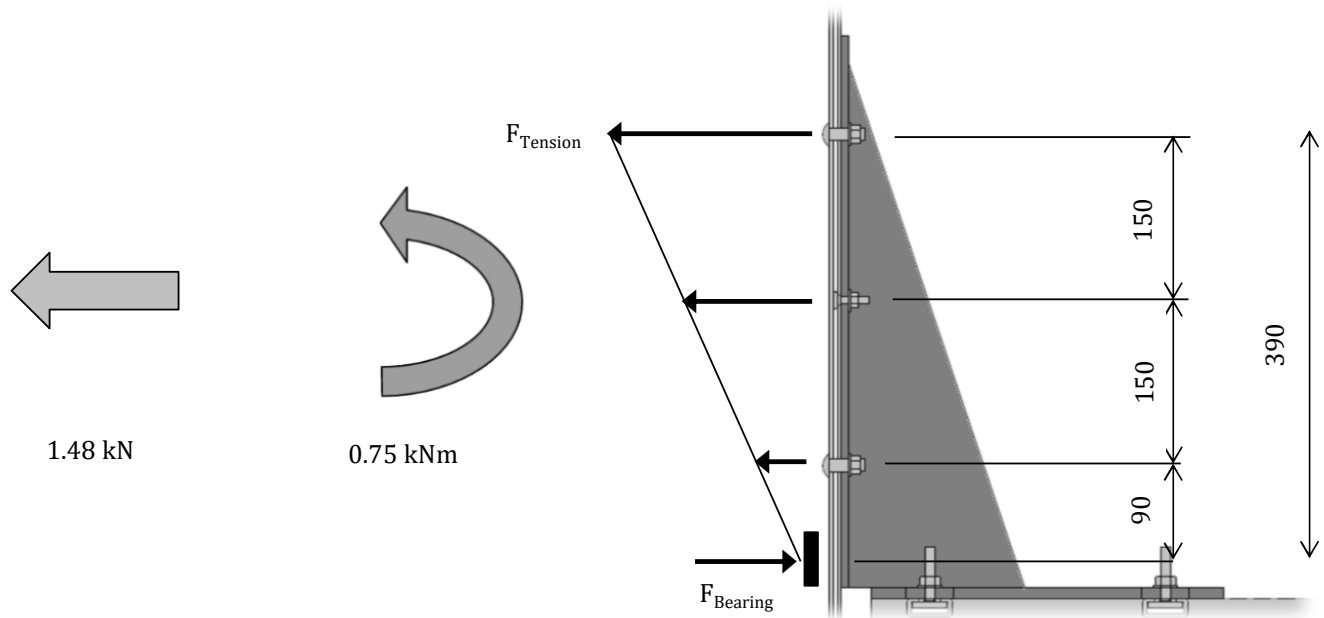
Design Output

$F_{Tension}$:	0.72 kN
$F_{Bearing}$:	2.76 kN

PREPARED BY *Gregory Guppy*

PROJECT *Manchester*

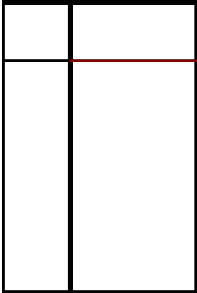
Date *Feb-25*

CLIENT *PP O'Connor*
Steel Post to Bracket Connection - to BS 449-2:1969

Design Input

Post Centres:	1.02 m	
Block:	750kg Block	
Steel Grade:	43	(S275)
Peak Velocity Pressure, q_p :	0.285 kN/m ²	
Pressure Zone:	Zone B	
Peressure Coefficient:	2.1	
Include 25% Overstress:	Yes	(Refer to Clause 13 of BS449-2:1969)
Bearing Length:	20 mm	
Applied Moment @ Connection:	0.75 kNm	
Design Moment @ Connection:	1.04 kNm	$(0.75 + 1.48 \times 0.39/2)$
Effective Lever Arm:	558 mm	
Max Bolt Tension:	1.86 kN	$(1.04/0.558)$
Bearing Force:	1.95 kN	(Sum of Bolt Tensions - Applied Lateral Load)

Design Output

$F_{Tension}$:	1.86 kN
$F_{Bearing}$:	1.95 kN

		Calculation Sheet		Sheet No.
				Project No. H25.0196 v1
PREPARED BY <i>Gregory Guppy</i>		PROJECT <i>Manchester</i>		
Date <i>Feb-25</i>		CLIENT <i>PP O'Connor</i>		
<u>TWf Load Combination LC2 & LC3 - 1.015m System with 750kg Block</u>				
<u>System Details</u>				
Effective Post Centres:	1.02 m			
Support Block:	750kg Block			
Hoarding Height:	3.0 m			
<u>Design Details</u>				
Factor of Safety - Overturning:	1.2	<u>Elevation of Hoarding</u>		
Factor of Safety - Sliding:	1.2			
Coefficient of Friction, μ :	0.4			
<u>Minimum Notional Horizontal Load/Crowd Loading*(*if applicable)</u>				
Notional Load:	0.74 kN/m			
Height of Load Applied, h:	1.1 m			
<u>Working Wind Load</u>				
Working Wind Load:	0.200 kN/m ²			
Pressure Zone:	Zone B			
Pressure Coefficient:	2.1			
<u>Applied Load</u>				
Total Overturning Moment- Site Side:	$(0.68 + 1.25) + (0.74 \times 1.015 \times 1.1)$	(MNH Load only applies)		
Total Overturning Moment - Site Side:	2.76 kNm			
Total Overturning Moment- Public Side:	$(0.68 + 1.25) + (0.74 \times 1.015 \times 1.1)$			
Total Overturning Moment- Public Side:	2.76 kNm			
Total Sliding Force:	$(0.45 + 0.84) + (0.74 \times 1.015)$			
Total Sliding Force:	2.04 kN			
<u>System Resistance</u>				
Overturning Resistance - Site Side:	4.31 kNm			
Overturning Resistance - Public Side:	5.04 kNm			
Mass of Assembly:	813 kg			
Sliding Resistance:	3.25 kN	$(0.4 \times 813/100)$		
<u>Result</u>				
Overturning - Site Side F.o.S:	1.56	>	1.2	$\therefore$ <u>O.K.</u>
Overturning - Public Side F.o.S:	1.83	>	1.2	$\therefore$ <u>O.K.</u>
Sliding F.o.S:	1.59	>	1.2	$\therefore$ <u>O.K.</u>

PREPARED BY

Gregory Guppy

PROJECT

Manchester

Date

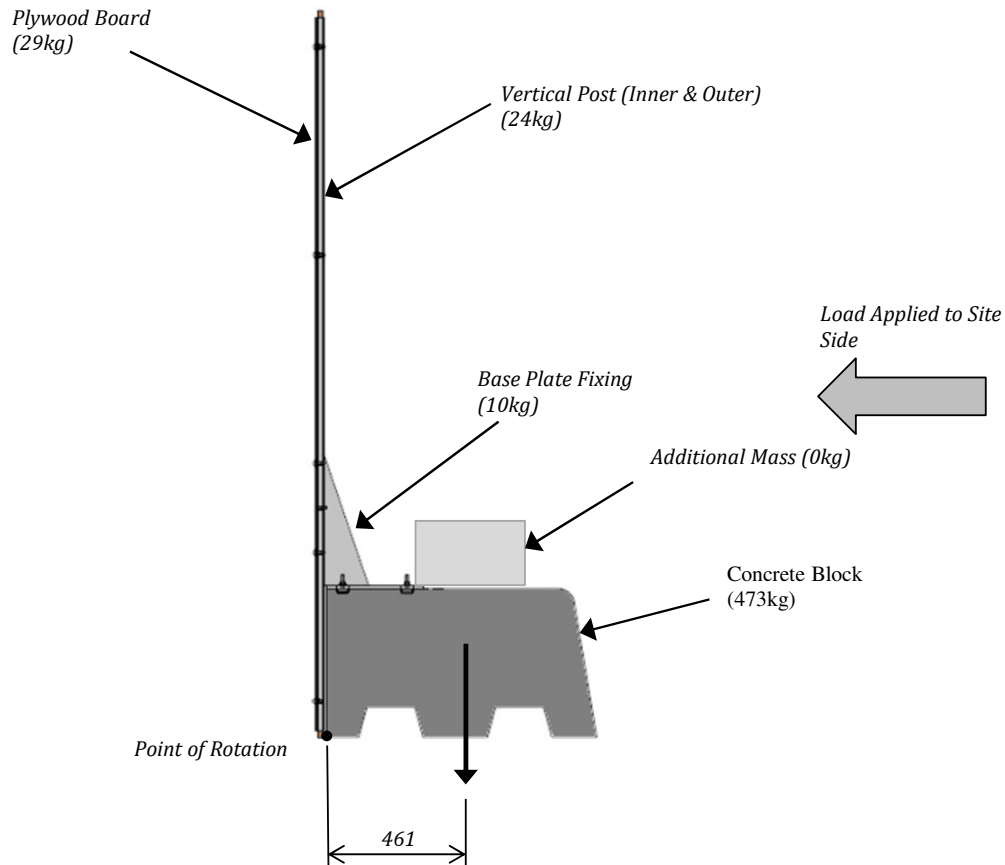
Feb-25

CLIENT

PP O'Connor

Stability Properties - 473kg Block + 0kg Additional Ballast - Load Applied to Site Side

System Details



Section Through Hoarding

Property Table

Component	Mass	Lever Arm	Overturning Resistance
Concrete Block	473 kg	461 mm	2.18 kNm
Additional Mass	0 kg	461 mm	0.00 kNm
Base Plate Fixing	10 kg	0 mm	0.00 kNm
Vertical Post (Inner & Outer)	24 kg	0 mm	0.00 kNm
Plywood Board	29 kg	0 mm	0.00 kNm
	536 kg		2.18 kNm

PREPARED BY

Gregory Guppy

PROJECT

Manchester

Date

Feb-25

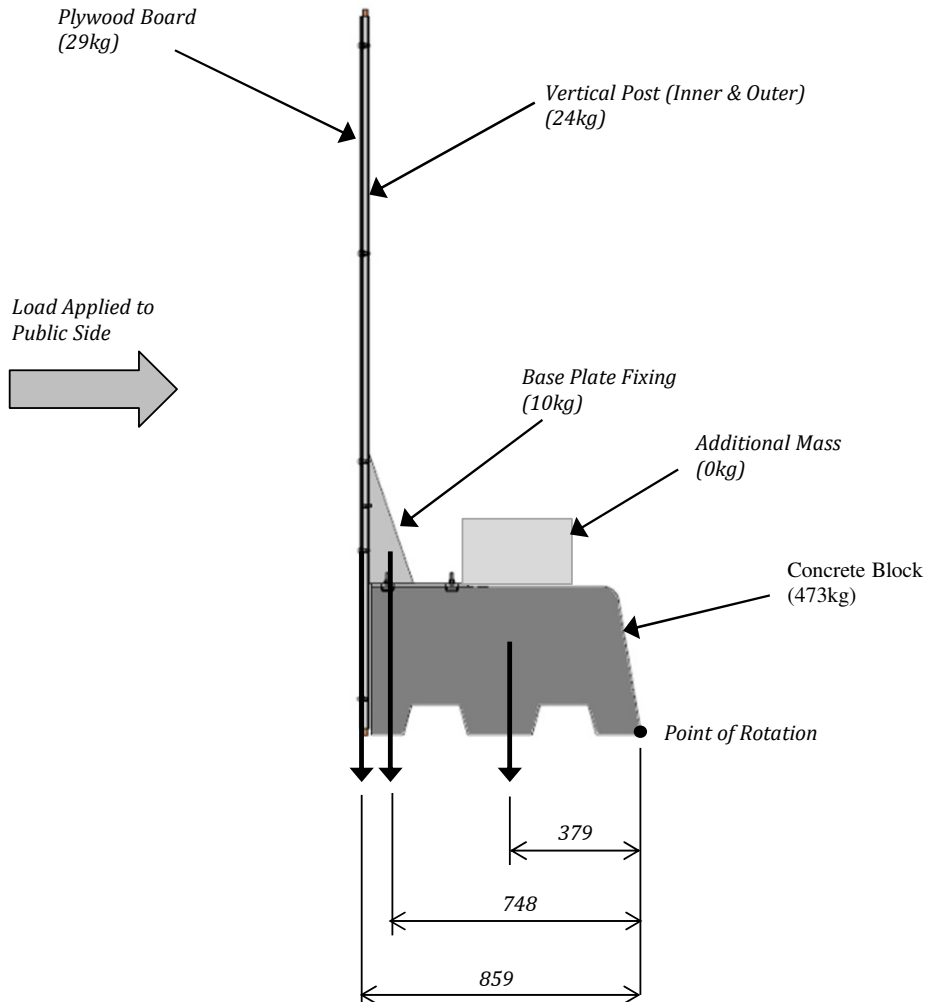
CLIENT

PP O'Connor

Stability Properties - 473kg Block + 0kg Additional Ballast - Load Applied to Public Side

System Details

Section Through Hoarding



Property Table

Component	Mass	Lever Arm	Overturning Resistance
Concrete Block	473 kg	379 mm	1.79 kNm
Additional Mass	0 kg	300 mm	0.00 kNm
Base Plate Fixing	10 kg	748 mm	0.07 kNm
Vertical Post (Inner & Outer)	24 kg	859 mm	0.21 kNm
Plywood Board	29 kg	859 mm	0.25 kNm
	536 kg		2.32 kNm

PREPARED BY *Gregory Guppy*

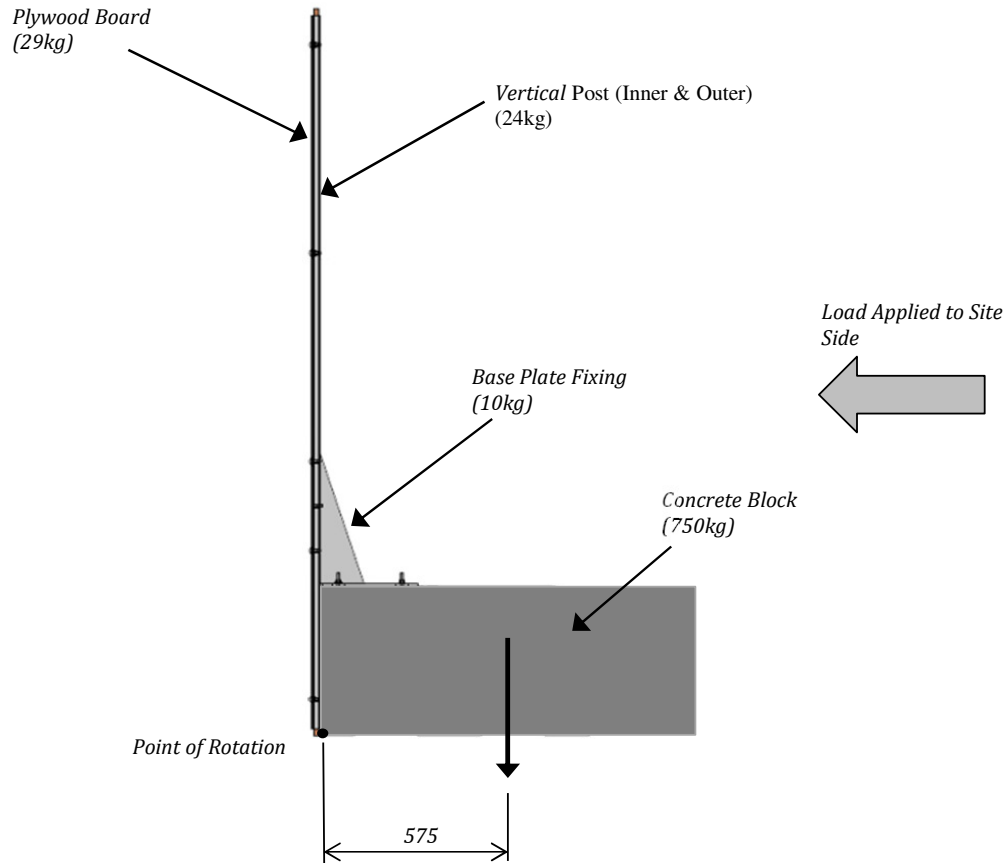
PROJECT *Manchester*

Date *Feb-25*

CLIENT *PP O'Connor*

Stability Properties - 750kg Block - Load Applied to Site Side

System Details



Section Through Hoarding

Property Table

Component	Mass	Lever Arm	Overturing Resistance
Concrete Block	750 kg	575 mm	4.31 kNm
Base Plate Fixing	10 kg	0 mm	0.00 kNm
Vertical Post (Inner & Outer)	24 kg	0 mm	0.00 kNm
Plywood Board	29 kg	0 mm	0.00 kNm
	813 kg		4.31 kNm

PREPARED BY

Gregory Guppy

PROJECT

Manchester

Date

Feb-25

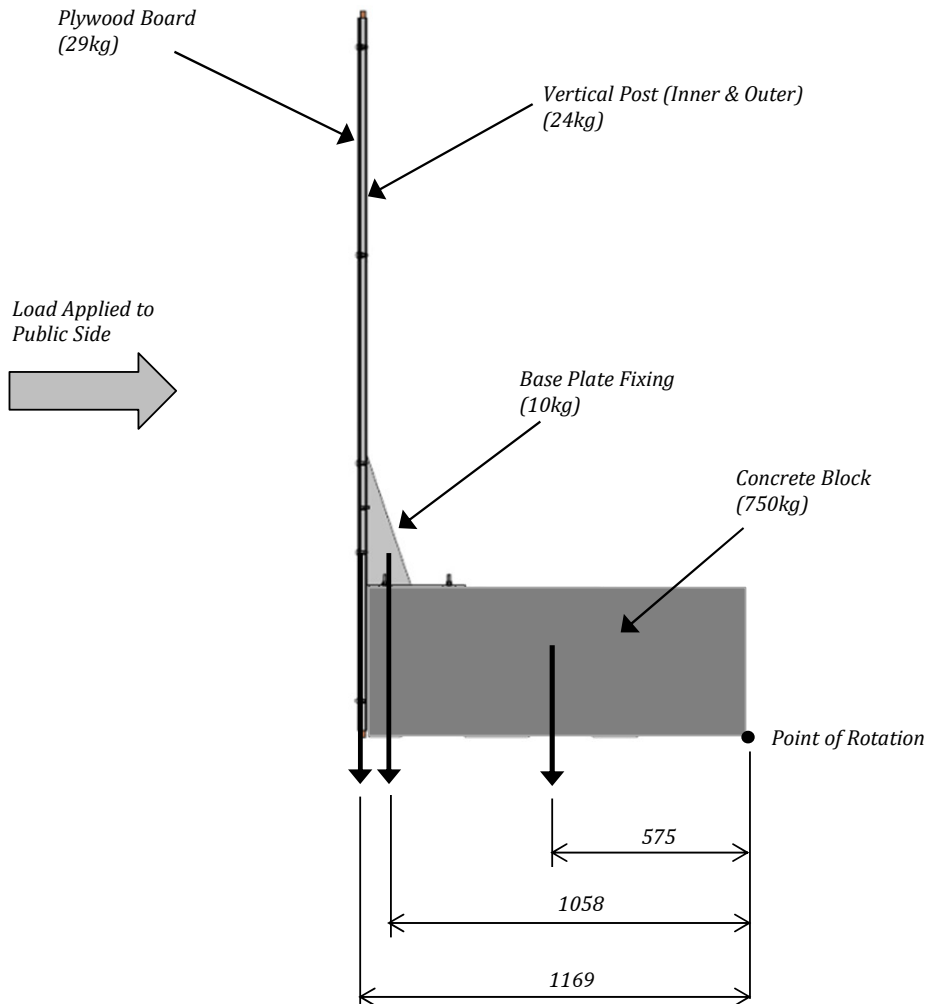
CLIENT

PP O'Connor

Stability Properties - 750kg Block - Load Applied to Public Side

System Details

Section Through Hoarding



Property Table

Component	Mass	Lever Arm	Overturning Resistance
Concrete Block	750 kg	575 mm	4.31 kNm
Base Plate Fixing	10 kg	1058 mm	0.11 kNm
Vertical Post (Inner & Outer)	24 kg	1169 mm	0.28 kNm
Plywood Board	29 kg	1169 mm	0.34 kNm
	813 kg		5.04 kNm

PREPARED BY

Gregory Guppy

PROJECT

Manchester

Date

Feb-25

CLIENT

PP O'Connor

Post Section Properties

Consideration of Local Buckling

The compound section of the steel post is relatively slender, and intuitively, local buckling at the extremities of the section may be an issue when the stress in the section approaches the yield stress of the material.

Section 20.5.2 of the Steel Designers Manual provides a method for calculating the effective section properties of profiled metal decks. As a means of accounting for local buckling of the steel post used for the hoard-it system, the same approach has been used.

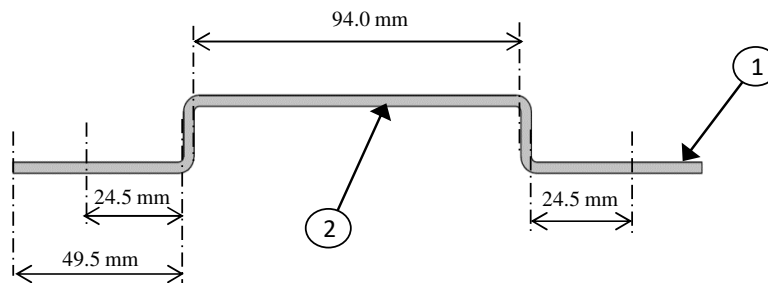
Effective Width of Section Between 'Stiffeners'

(Stiffeners are classed as corners or bends in a plate)

The effective width, b_e , of the section adjacent to any stiffener/bend is given by the equation below:

$$b_e = \frac{857t}{p_{y\Box}^{0.5}} \left(1 - \frac{187t}{b \times p_{y\Box}^{0.5}} \right) \text{ but } \leq b$$

Inner Post Upright



① $b_e = 49 \text{ mm}$ (As this outstand is effectively a cantilever, the effective length is $2l$, hence, the effective width has been taken as $b_e/2$)

② $b_e = 99 \text{ mm}$ $99 \text{ mm} > 94 \text{ mm}$. Therefore full width effective

PREPARED BY *Gregory Guppy*

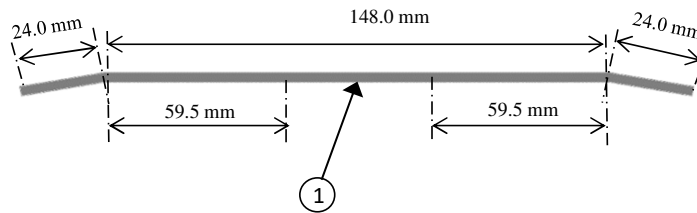
PROJECT *Manchester*

Date *Feb-25*

CLIENT *PP O'Connor*

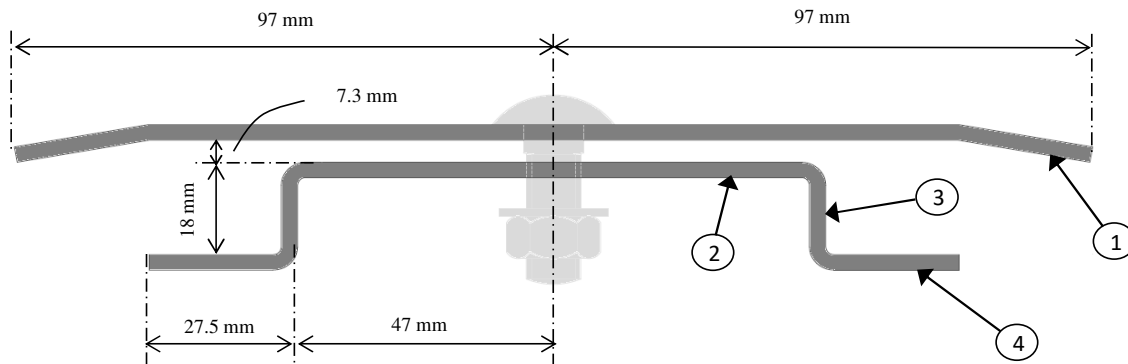
Post Section Properties

Outer Upright Post



① $b_e = 119 \text{ mm}$ $119 \text{ mm} < 148 \text{ mm}$. Therefore 59.5 mm width effective adjacent to each bend

Section Properties when Inner Upright is in Compression



Section Properties

Section	Length (mm)	Height (mm)	Area (mm ²)	Dist to centroid (mm)	Ay (mm ³)	y (mm)	bd ³ /12 (mm ³)	Ay ² (mm ³)	I (mm ³)
1	97.0	3.0	291.0	29.8	8671.8	8.4	218	20300	20518
2	47.0	3.0	141.0	19.5	2749.5	1.9	106	535	641
3	3.0	18.0	54.0	12.0	648.0	9.4	1458	4820	6278
4	27.5	3.0	82.5	1.5	123.8	19.9	62	32828	32890
Overall	-	-	1137	-	21.4	-	-	-	120654

Elastic Modulus

$Z_{xx}:$ 5625 mm^3

PREPARED BY *Gregory Guppy*

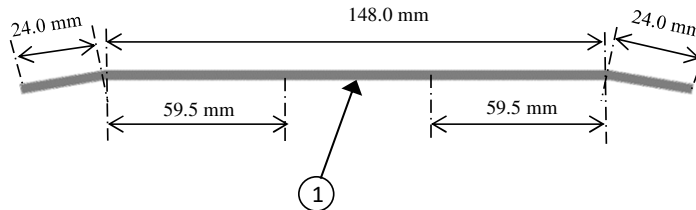
PROJECT *Manchester*

Date *Feb-25*

CLIENT *PP O'Connor*

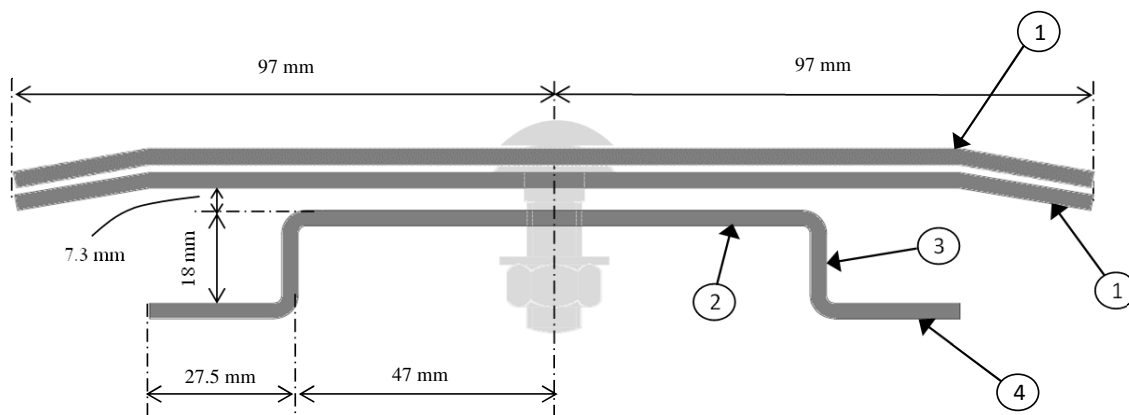
Double Post Section Properties

Outer Upright Post



① $b_e = 119 \text{ mm}$ $119 \text{ mm} < 148 \text{ mm}$. Therefore 59.5 mm width effective adjacent to each bend

Section Properties when Inner Upright is in Compression - Doubled Up Outer



Section Properties

Section	Length (mm)	Height (mm)	Area (mm ²)	Dist to centroid (mm)	Ay (mm ³)	y (mm)	bd ³ /12 (mm ³)	Ay ² (mm ³)	I (mm ³)
1 inner	97.0	3.0	291.0	29.8	8671.8	4.5	218	5916	6134
1 outer	97.0	3.0	291.0	32.8	9544.8	7.5	218	16407	16625
2	47.0	3.0	141.0	19.5	2749.5	5.8	106	4729	4835
3	3.0	18.0	54.0	12.0	648.0	13.3	1458	9540	10998
4	27.5	3.0	82.5	1.5	123.8	23.8	62	46697	46759
Overall	-	-	1719	-	25.3	-	-	-	170700

Elastic Modulus

$Z_{xx}:$ 6749 mm^3

PREPARED BY Gregory Guppy

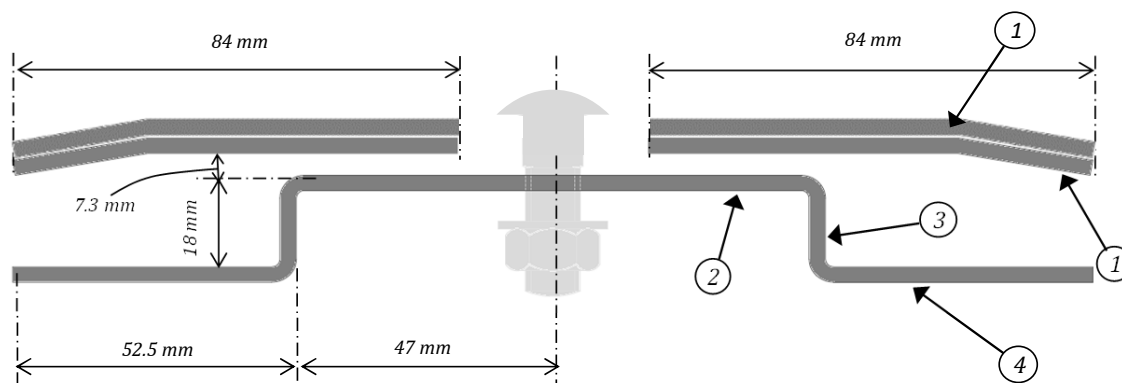
PROJECT Manchester

Date Feb-25

CLIENT PP O'Connor

Post Section Properties

Section Properties when Outer Upright is in Compression



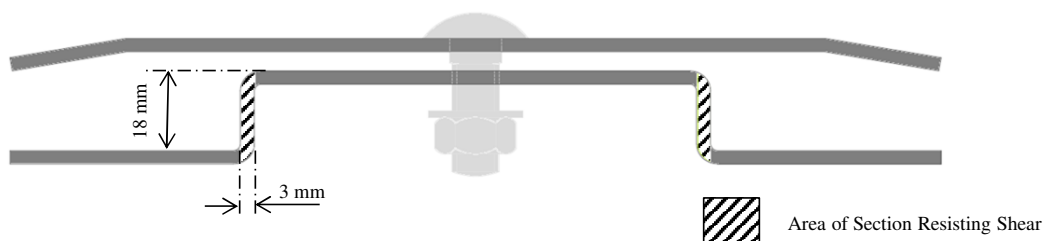
Section Properties (Doubled Up Outer Upright)

Section	Length (mm)	Height (mm)	Area (mm ²)	Dist to centroid (mm)	Ay (mm ³)	y (mm)	bd ³ /12 (mm ³)	Ay ² (mm ³)	I (mm ³)
1 inner	83.5	3.0	250.5	29.8	7464.9	7.2	188	12876	13064
1 Outer	83.5	3.0	250.5	32.8	8216.4	10.2	188	25907	26095
2	47.0	3.0	141.0	19.5	2749.5	3.1	106	1382	1487
3	3.0	18.0	54.0	12.0	648.0	10.6	1458	6102	7560
4	52.5	3.0	157.5	1.5	236.3	21.1	118	70323	70441
Overall	-	-	1707	-	22.6	-	-	-	237296

Elastic Modulus

Z_{xx} : 10486 mm³

Shear Area

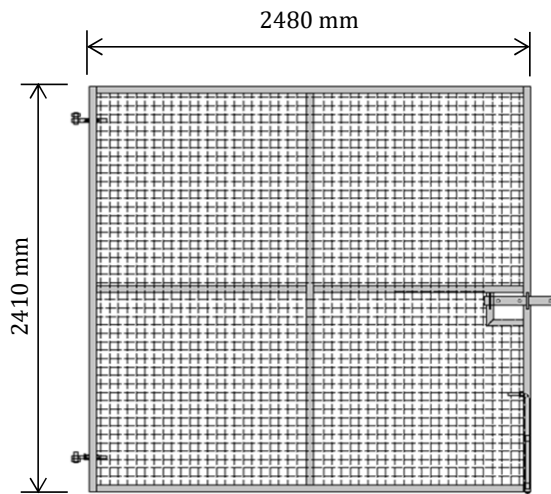
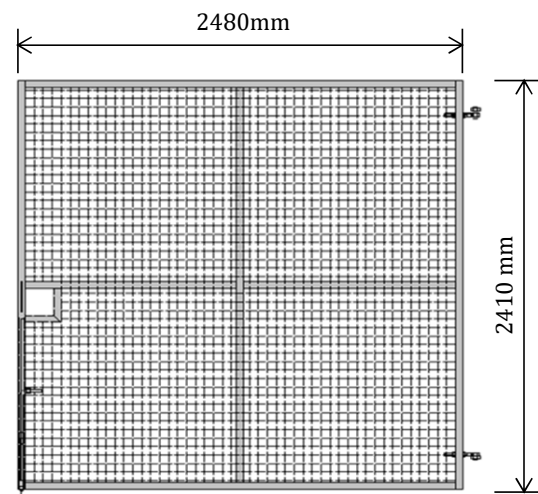


Shear Area: 108 mm²

PREPARED BY *Gregory Guppy*

PROJECT *Manchester*

Date *Feb-25*

CLIENT *PP O'Connor*
5m Mesh Vehicle Gate

Male Leaf

Female Leaf
Gate Properties

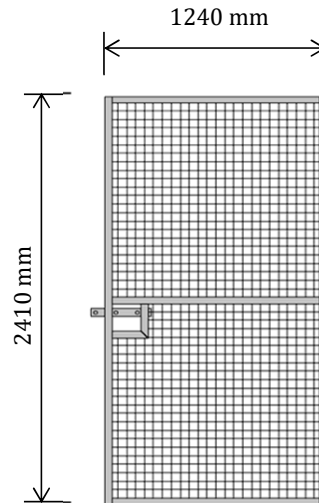
	Male	Female
Cladding	Mesh	
Height	2410 mm	2410 mm
Width	2480 mm	2480 mm
Weight	61 kg	58 kg
Area of Rectangular Solids	0.61 m ²	0.61 m ²
$C_{pr} = 2$	1.23 m ²	1.23 m ²
Area of Circular Solids	0.69 m ²	0.69 m ²
$C_{pc} = 1.2$	0.82 m ²	0.82 m ²
Total Area	5.98 m ²	5.98 m ²
Effective Area (Inc. of Pressure Coefficients)*	2.05 m ²	2.05 m ²

* The Effective Area = (Area of Rectangular Solids x C_{pr}) + (Area of Circular Solids x C_{pc}).
The Net Pressure can then be calculated by multiplying the Effective Area by the Peak Velocity Pressure.

PREPARED BY *Gregory Guppy*

PROJECT *Manchester*

Date *Feb-25*

CLIENT *PP O'Connor*
1.2m Mesh Pedestrian Gate

Single Leaf
Gate Properties

	<i>Single Leaf</i>
<i>Cladding</i>	<i>Mesh</i>
<i>Height</i>	<i>2410 mm</i>
<i>Width</i>	<i>1240 mm</i>
<i>Weight</i>	<i>40 kg</i>
<i>Area of Rectangular Solids</i>	<i>0.38 m²</i>
$C_{pr} = 2$	<i>0.75 m²</i>
<i>Area of Circular Solids</i>	<i>0.51 m²</i>
$C_{pc} = 1.2$	<i>0.61 m²</i>
<i>Total Area</i>	<i>2.99 m²</i>
<i>Effective Area (Inc. of Pressure Coefficients)*</i>	<i>1.37 m²</i>

* The Effective Area = (Area of Rectangular Solids x C_{pr}) + (Area of Circular Solids x C_{pc}).
The Net Pressure can then be calculated by multiplying the Effective Area by the Peak Velocity Pressure.

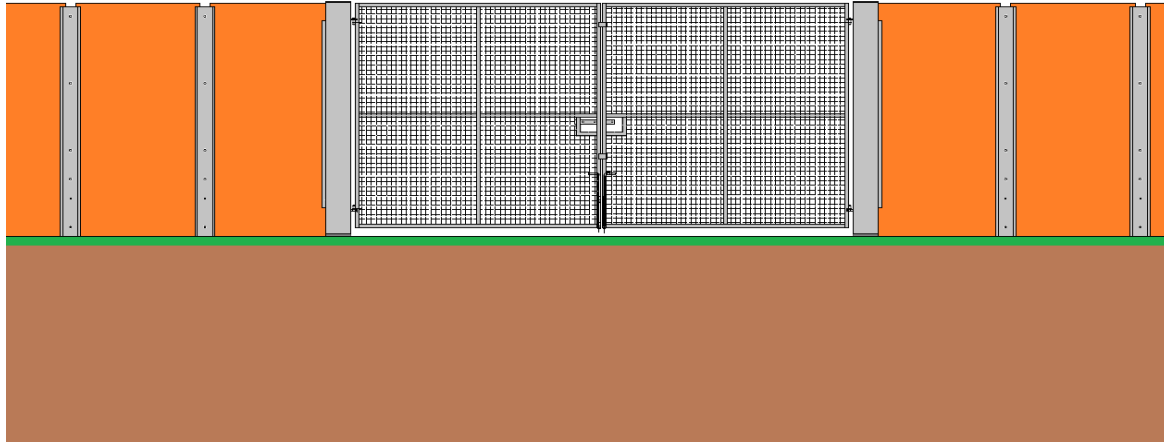
PREPARED BY *Gregory Guppy*

PROJECT *Manchester*

Date *Feb-25*

CLIENT *PP O'Connor*

Gate Design Input



Gate Information

Gate Type: *5m Mesh Vehicle Gate*
Gate Width: *5.00 m*
Gate Height: *2.41 m*
Adjacent Bay Width: *1.32 m*
Adjacent Bay Height: *2.44 m*

Gate Post Information

Gate Post Section: *100x100x4.0 SHS*
Steel Grade: *Strongbox (S235)*
Elastic Modulus, Z_{xx} : *45300 mm³*
Elastic Modulus, Z_{yy} : *45300 mm³*
Inertia, I_{xx} : *2260000 mm⁴*
Inertia, I_{yy} : *2260000 mm⁴*
Shear Area, A_{xx} : *800 mm²*
Shear Area, A_{yy} : *800 mm²*
Include 25% Overstress: *Yes* (Refer to Clause 13 of BS449-2:1969)

xx and yy relate to the global coordinates of the hoarding system, where xx is along the hoarding line and yy is perpendicular to the hoarding line.

Wind Loading Information

Peak Velocity Pressure, q_p : *0.285 kN/m²*
Working Wind Load: *0.200 kN/m²* (Refer to BS 5975)
Pressure Coefficient - In Run: *2.1* (When gates are solid and closed)
Pressure Coefficient - Edge: *2.1* (Applied to adjacent hoarding and solid gates when open)

PREPARED BY *Gregory Guppy*

PROJECT *Manchester*

Date *Feb-25*

CLIENT *PP O'Connor*

Gate Load Cases

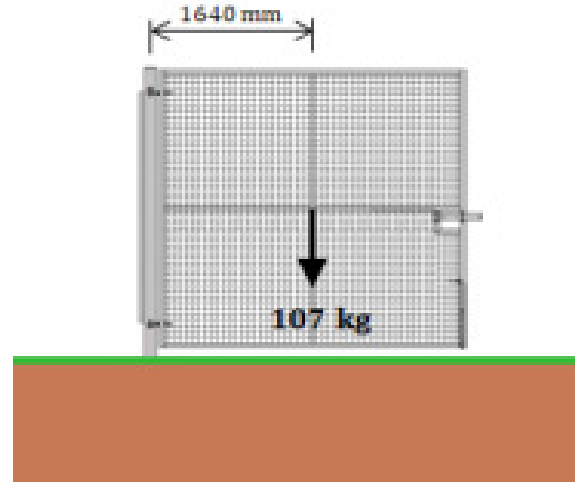
Load Case 1 - Self Weight of Gate

Lever Arm: *1390 mm*

Weight of Gate: *61 kg*

BM @ Post Base, M_o : *0.85 kNm*

Shear @ Post Base, Q_o : *0.00 kN*



Load Case 2 - Maximum Wind

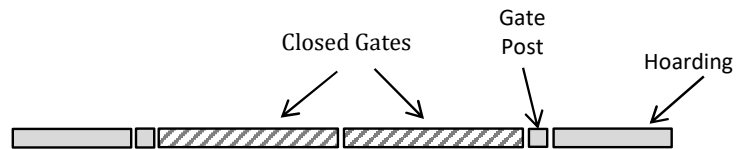
The gates are assumed to be shut under maximum wind conditions as site activities will have ceased.

Load on Post from Hoarding: *0.96 kN*

Load on Post from Gate: *1.23 kN*

BM @ Post Base, M_o : *2.65 kNm*

Shear @ Post Base, Q_o : *2.19 kN*



Plan of Gate

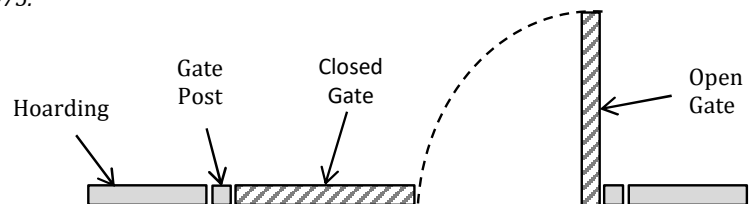
Load Case 3 - Working Wind

The maximum wind that the gates are likely to be exposed to when they are open is the working wind, as defined in BS5975.

The working wind is given as 0.200 kN/m^2 .

Load on Post from Open Gate: *0.57 kN*

(The wind is assumed to act perpendicular to the open gate and therefore any load from the adjacent hoarding is negligible.)



Plan of Gate

BM @ Post Base, M_o : *0.69 kNm*

Shear @ Post Base, Q_o : *0.57 kN*

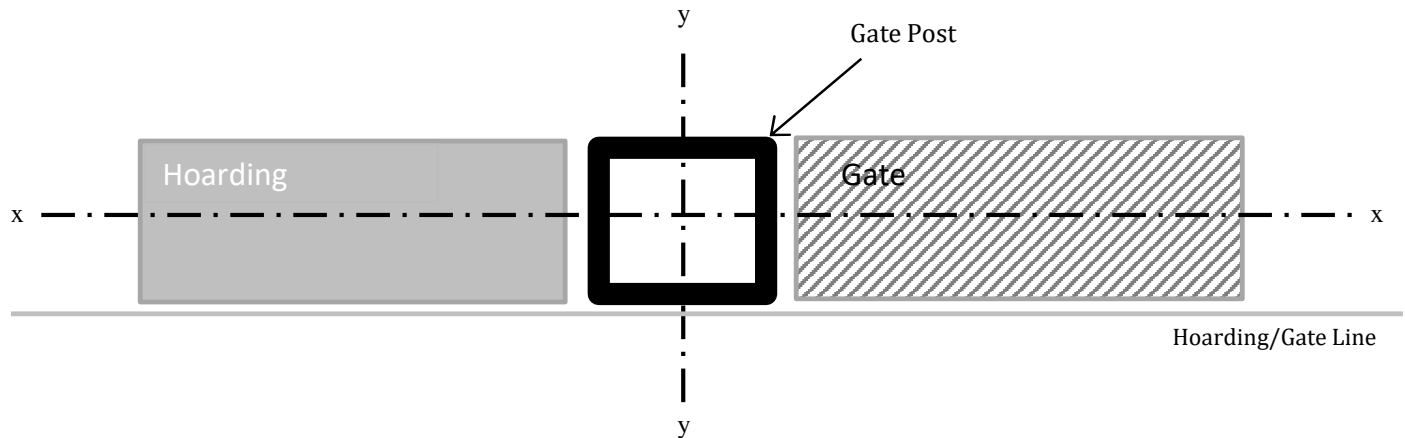
PREPARED BY *Gregory Guppy*

PROJECT *Manchester*

Date *Feb-25*

CLIENT *PP O'Connor*

Load Combination 1 - Maximum Wind and Gate Self Weight



Applied Load

M_{xx} : 2.65 kNm (Moment due to Maximum Wind)
 M_{yy} : 0.85 kNm (Moment due to Gate Self Weight)
 Q_{xx} : 0.00 kN (Shear due to Gate Self Weight)
 Q_{yy} : 2.19 kN (Shear due to Maximum Wind)

Gate Post Bending Check

Allowable Stress, p_{bc} : 155 N/mm² (From Table 2 of BS449-2:1969 - pro-rated for S235)
 Max Allowable Stress, p_{bcx} & p_{bcy} : 194 N/mm² (Inclusive of 25% Overstress as allowed in Clause 13 of BS449-2:1969)

 Maximum Stress about x-x, f_{bcx} : 59 N/mm² < 194 N/mm² ∴ O.K.
 Maximum Stress about y-y, f_{bcy} : 19 N/mm² < 194 N/mm² ∴ O.K.

Combined Bending Check

$$\frac{f_{bcx}}{p_{bcx}} + \frac{f_{bcy}}{p_{bcy}} \leq 1$$

0.40 < 1 ∴ O.K.

PREPARED BY Gregory Guppy

PROJECT Manchester

Date Feb-25

CLIENT PP O'Connor

Load Combination 1 - Maximum Wind and Gate Self Weight

Gate Post Shear Check

In y-y Direction

Applied Average Stress, f_q : 2.7 N/mm²
 Allowable Stress, p_q : 95 N/mm² (From Table 11 of BS449-2:1969 - Pro-rated for S235)
 Maximum Allowable Stress, p_q : 119 N/mm² (Inclusive of 25% Overstress as allowed in Clause 13 of BS449-2:1969)

Shear Result

119 N/mm² > 3 N/mm² ∴ O.K.

In x-x Direction

Applied Average Stress, f_q : 0.0 N/mm²
 Allowable Stress, p_q : 95 N/mm² (From Table 11 of BS449-2:1969 - Pro-rated for S235)
 Maximum Allowable Stress, p_q : 119 N/mm² (Inclusive of 25% Overstress as allowed in Clause 13 of BS449-2:1969)

Shear Result

119 N/mm² > 0 N/mm² ∴ O.K.

Bending and Shear Check

Resultant Tensile Stress, f_{bt} : 77 N/mm²
 Shear Stress, f_q : 2.7 N/mm²
 Equivalent Stress, $f_e = \sqrt{(f_{bt}^2 + 3f_q^2)}$
 Equivalent Stress, f_e : 77 N/mm²
 Allowable Equivalent Stress, P_e : 215 N/mm² (From Table 1 of BS449-2:1969 - Pro-rated for S235)

215 N/mm² > 77 N/mm² ∴ O.K.

PREPARED BY *Gregory Guppy*

PROJECT *Manchester*

Date *Feb-25*

CLIENT *PP O'Connor*

Load Combination 1 - Maximum Wind and Gate Self Weight

Gate Post Deflection

About y-y Axis (Due to SW of Gate)

Applied Moment, M_{yy} : *0.85 kNm*

Dimension, a : *1205 mm*

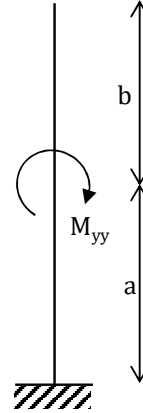
Dimension, b : *1200 mm*

$$\text{Deflection @ Top of Post} = \frac{M_{yy} a^2}{2EI} \left(1 + \frac{2b}{a} \right)$$

Deflection @ Top of Post: *4.0 mm*

Allowable Deflection: *10.0 mm**

$$10.0 \text{ mm} > 4.0 \text{ mm} \quad \therefore \underline{O.K.}$$



*The deflection due to the self weight of the gate has been limited to 10mm, as opposed to Height/50, as the deflection due to the self weight of the gate acts away from the adjacent connected boards.

This deflection reduces the amount of 'grip' of the board within the post. To ensure that the integrity of the system is maintained, the more stringent deflection limit of 10mm has been applied.

About x-x Axis (Due to Maximum Wind)

Applied Total Load, W : *2.19 kN*

Dimension, a : *2440 mm*

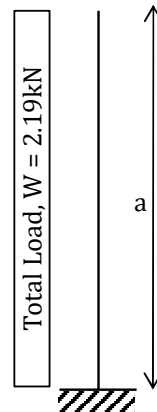
$$\text{Deflection @ Top of Post} = \frac{W a^3}{8EI}$$

Deflection @ Top of Post: *8.6 mm*

Allowable Deflection: *Height/ 50*

Allowable Deflection: *48.8 mm*

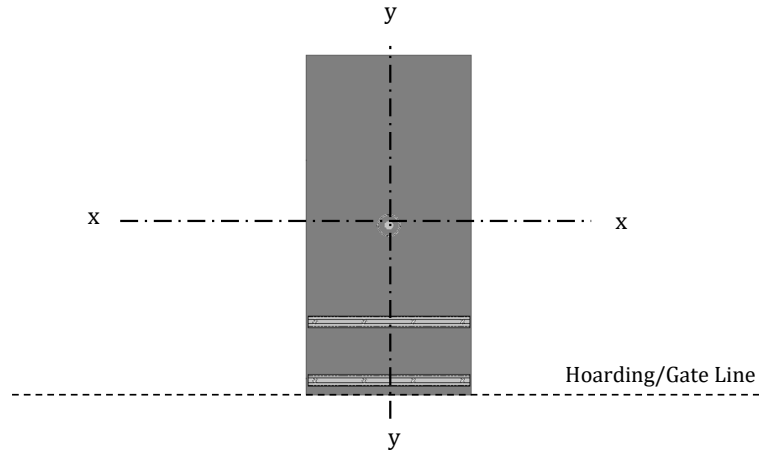
$$48.8 \text{ mm} > 8.6 \text{ mm} \quad \therefore \underline{O.K.}$$



PREPARED BY *Gregory Guppy*

PROJECT *Manchester*

Date *Feb-25*

CLIENT *PP O'Connor*
Load Combination 1 - Concrete Base Block Overturning & Sliding
Plan of Concrete Block

Design Information

Support Block: *750kg Block (Strong Axis) + 473kg Block*
Upper' Surface: *Hardened Concrete - Cast Face*
Lower' Surface: *Soil - Granular*
Coefficient of Static Friction, m : *0.4 (Refer to Table 24 of BS5975)*
Overturning Required F.o.S.: *1.20*
Sliding Required F.o.S.: *1.20*

Applied Load

Moment @ Base, M_{xx} : *2.65 kNm*
Moment @ Base, M_{yy} : *0.85 kNm*
Sliding Force @ Base, Q_{xx} : *0.00 kN*
Sliding Force @ Base, Q_{yy} : *2.19 kN*

Overturning Check

Overturning Capacity, M_{cxx} : *5.97 kNm* $F.o.S. = 2.25$ $>$ *1.20* $\therefore$ *O.K.*
Overturning Capacity, M_{cyy} : *3.50 kNm* $F.o.S. = 4.13$ $>$ *1.20* $\therefore$ *O.K.*

Combined Check

$$\left(\frac{M_{xx}}{(M_{cxx} \div F.o.S.)} \right)^2 + \left(\frac{M_{yy}}{(M_{cyy} \div F.o.S.)} \right)^2 \leq 1.0$$

0.37 $<$ *1.00* $\therefore$ *O.K.*

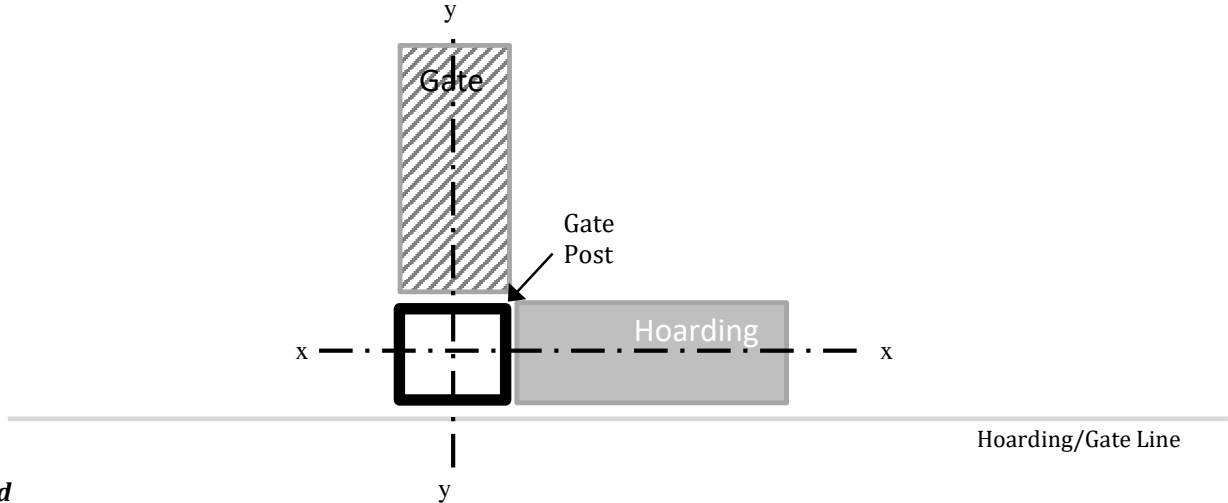
Sliding Check

Resultant Sliding Force: *2.19 kN*
System Weight: *1349 kg*
Sliding Resistance: *5.40 kN* $F.o.S. = 2.46$ $>$ *1.20* $\therefore$ *O.K.*

PREPARED BY *Gregory Guppy*

PROJECT *Manchester*

Date *Feb-25*

CLIENT *PP O'Connor*
Load Combination 2 - Working Wind and Gate Self Weight

Applied Load

M_{xx} : 0.85 kNm (Moment due to Gate Self Weight)
 M_{yy} : 0.69 kNm (Moment due to Working Wind)
 Q_{xx} : 0.57 kN (Shear due to Working Wind)
 Q_{yy} : 0.00 kN (Shear due to Gate Self Weight)

Gate Post Bending Check

Allowable Stress, p_{bc} : 155 N/mm² (From Table 2 of BS449-2:1969 - Pro-rated for S235)
 Max Allowable Stress, p_{bcx} & p_{bcy} : 194 N/mm² (Inclusive of 25% Overstress as allowed in Clause 13 of BS449-2:1969)

Maximum Stress about x-x, f_{bcx} : 19 N/mm² < 194 N/mm² ∴ O.K.
 Maximum Stress about y-y, f_{bcy} : 15 N/mm² < 194 N/mm² ∴ O.K.

Combined Bending Check

$$\frac{f_{bcx}}{p_{bcx}} + \frac{f_{bcy}}{p_{bcy}} \leq 1$$

0.18 < 1 ∴ O.K.

PREPARED BY *Gregory Guppy*

PROJECT *Manchester*

Date *Feb-25*

CLIENT *PP O'Connor*

Load Combination 2 - Working Wind and Gate Self Weight

Gate Post Shear Check

In y-y Direction

Applied Average Stress, f_q : 0.0 N/mm^2
 Allowable Stress, p_q : 95 N/mm^2 (From Table 11 of BS449-2:1969 - Pro-rated for S235)
 Maximum Allowable Stress, p_q : 119 N/mm^2 (Inclusive of 25% Overstress as allowed in Clause 13 of BS449-2:1969)

Shear Result

$119 \text{ N/mm}^2 > 0 \text{ N/mm}^2 \therefore \underline{O.K.}$

In x-x Direction

Applied Average Stress, f_q : 0.7 N/mm^2
 Allowable Stress, p_q : 95 N/mm^2 (From Table 11 of BS449-2:1969 - Pro-rated for S235)
 Maximum Allowable Stress, p_q : 119 N/mm^2 (Inclusive of 25% Overstress as allowed in Clause 13 of BS449-2:1969)

Shear Result

$119 \text{ N/mm}^2 > 1 \text{ N/mm}^2 \therefore \underline{O.K.}$

Bending and Shear Check

Resultant Tensile Stress, f_{bt} : 34 N/mm^2
 Shear Stress, f_q : 0.7 N/mm^2
 Equivalent Stress, $f_e = \sqrt{(f_{bt}^2 + 3f_q^2)}$
 Equivalent Stress, f_e : 34 N/mm^2
 Allowable Equivalent Stress, P_e : 215 N/mm^2 (From Table 1 of BS449-2:1969 - Pro-rated for S235)

$215 \text{ N/mm}^2 > 34 \text{ N/mm}^2 \therefore \underline{O.K.}$

PREPARED BY *Gregory Guppy*

PROJECT *Manchester*

Date *Feb-25*

CLIENT *PP O'Connor*

Load Combination 2 - Working Wind and Gate Self Weight

Gate Post Deflection

About y-y Axis (Due to Working Wind)

Applied Total Load, W : *0.57 kN*

Dimension, a : *2440 mm*

Deflection @ Top of Post = $\frac{Wa^3}{8EI}$

Deflection @ Top of Post: *2.2 mm*

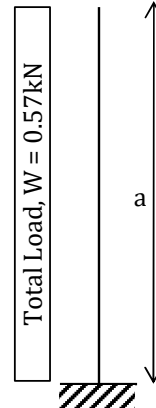
Allowable Deflection: *10.0 mm**

10.0 mm

>

2.2 mm

∴ O.K.



*The deflection due to the self weight of the gate has been limited to 10mm, as opposed to Height/, as the deflection due to the self weight of the gate acts away from the adjacent connected boards.

This deflection reduces the amount of 'grip' of the board within the post. To ensure that the integrity of the system is maintained, the more stringent deflection limit of 10mm has been applied.

About x-x Axis (Due to SW Gate)

Applied Moment, M_{yy} : *0.85 kNm*

Dimension, a : *1205 mm*

Dimension, b : *1200 mm*

Deflection @ Top of Post = $\frac{M_{yy} a^2}{2EI} \left(1 + \frac{2b}{a} \right)$

Deflection @ Top of Post: *4.0 mm*

Allowable Deflection: *Height/ 50*

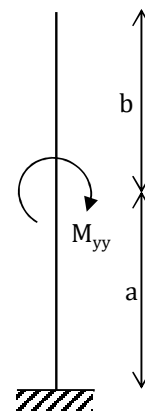
Allowable Deflection: *48.8 mm*

48.8 mm

>

4.0 mm

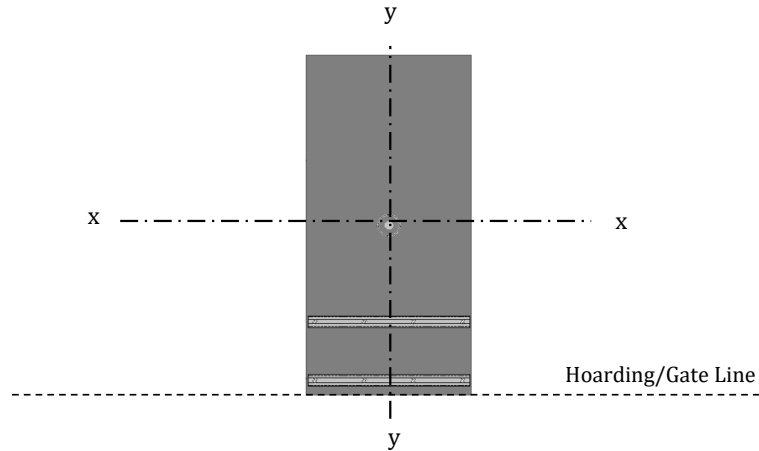
∴ O.K.



PREPARED BY *Gregory Guppy*

PROJECT *Manchester*

Date *Feb-25*

CLIENT *PP O'Connor*
Load Combination 2 - Concrete Base Block Overturning & Sliding
Plan of Concrete Block

Design Information

Support Block: *750kg Block (Strong Axis) + 473kg Block*
Upper' Surface: *Hardened Concrete - Cast Face*
Lower' Surface: *Soil - Granular*
Coefficient of Static Friction, m: *0.4 (Refer to Table 24 of BS5975)*
Overturning Required F.o.S.: *1.20*
Sliding Required F.o.S.: *1.20*

Applied Load

Moment @ Base, M_{xx} : *0.85 kNm*
Moment @ Base, M_{yy} : *0.69 kNm*
Sliding Force @ Base, Q_{xx} : *0.57 kN*
Sliding Force @ Base, Q_{yy} : *0.00 kN*

Overturning Check

Overturning Capacity, M_{cxx} : *5.97 kNm* *F.o.S. = 7.04* *>* *1.20* *∴ O.K.*
Overturning Capacity, M_{cyy} : *3.50 kNm* *F.o.S. = 5.07* *>* *1.20* *∴ O.K.*

Combined Check

$$\left(\frac{M_{xx}}{(M_{cxx} \div F.o.S.)} \right)^2 + \left(\frac{M_{yy}}{(M_{cyy} \div F.o.S.)} \right)^2 \leq 1.0$$

0.09 *<* *1.00* *∴ O.K.*

Sliding Check

Resultant Sliding Force: *0.57 kN*
System Weight: *1349 kg*
Sliding Resistance: *5.40 kN* *F.o.S. = 9.41* *>* *1.20* *∴ O.K.*