Site:	31-33 Bloombury Way	**Client:** MW Scaffolding	JOSEPH DESIGN LTD CONSULTING CIVIL & STRUCTURAL
Job:	`091703	Task: | Sheet No: **1.00**	48 Lewes Road Brighton BN2 3HW Tel: 01273760116 E-mail: info@josephdesign.co.uk
By:	**W.A**	**Chkd:**	Date: 20-Sep-17
Ref	CALCULATION		

Job description

31 -33 Bloombury way
London

Codes of Practice

BS EN12811-Part 1:2003 Scaffolds — Performance requirements and general design

BS EN12810-Part 1 and 2:2003 Product specifications, particular methods of structural design (respectively)

NASC TG20:13 Guide to good practice for Scaffolding with tube and fittings

BS EN39:2001 BS 1139-2:1991 EN 74-1: Metal scaffolding tube and coupler specification/tests/requirements

BS 6399: Part 2: Code of practice for wind loads

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Job: `091703	Task:	Sheet No: ***2.00***	
By: **W.A**	***Chkd:***		Date: 20-Sep-17

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Drawing Reference Number

Calculations are to be read in conjunction with Joseph Design drawing number:

* 091703-01

* 091703-02

Approach used for Design

Many published figures for scaffolding materials are given in permissible stress values giving a safety factor of 1.65 to 1, as opposed to BS EN 12811 - 1 that requires limit state approach. Limit state applies a partial safety factor of 1.5 to 1 for imposed loads and 1.1 for resistance giving a single factor of 1.5 x 1.1 = 1.65 similar to permissible stress. This approach, combined with the use of TG20:13 is used in these calculations unless otherwise noted.

The independent access scaffold is subject to loading of an imposed load of $2kN/m^2$ for first lift and $1kN/m^2$ for second lift

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By:	**W.A**	***Chkd:***		Date: 20-Sep-17
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ABSTRACT

SUMMARY OF RESULTS

Use double boards on first level

Use transoms at a max. 1200mm c/c for access scaffold

Max. Inside Standard load = 15.93 kN

Max. Outside Standard load = 11.56kN

Use X Beam for temporary roof

Spine beam use 4 X beam

Use 44 Ties

Wind Loading

Note symbols

V_b = Basic Wind Speed (fig 6 - BS 6399, Page 19)

S_a = Site Altitude Factor (Height Above Sea Level in metres)

S_d = Site Direction (Table 3 - BS 6399, Page 27) Worst Case = 1

S_s = Seasonal Factor (Table D.1 - BS 6399, Page 104) Worst Case = 1

S_p = Probability Factor (2.2.2.5 - BS 6399, Page 27) Worst Case = 1

S_b = Terrain and Building Factor (Table 4 - BS 6399, Pt. 2 Page 28)

C_a = Size Effect Factor (fig 4 - BS 6399, Page 16)

C_f = is the aerodynamice force coeffcient for the component TG20 page 148 for scaffold tube = 1.2

C_{pe} = External Pressure Coefficient (39.10.3 - TG20, Page 108)

C_v = Containment Value (Obtained from manufacturers details)

V_b =	21.000 m/s	S_s =	1.000	C_a =	0.920
S_a =	29.000 m	S_p =	1.000	C_f =	0.700
S_d =	1.000	S_b =	1.920	C_v =	60

V_b =	21.00	S_s =	1.00	V_s =	21.61 m/s
S_a =	1.03	S_p =	1.00	V_e =	41.49 m/s
S_d =	1.00			Q =	1.06 kN/m^2

q is dynamic pressure

$W_{(Sheeted)}$ = 0.90 kN/m^2 [q x Cpe x Ae]

$W_{(Netted)}$ = 0.54 kN/m^2 [$W_{(sheeted)}$ x C_v]

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Job: `091703	Task:	Sheet No: ***6.00***	
By: **W.A**	***Chkd:***		Date: 20-Sep-17

Ref CALCULATION

Dynamic wind pressure and suction force

Dynamic wind pressure and suction force

Sheeted

Wind pressure 0.85 Cpe (BS6399, Part 2, Table 5, pg 31, interpolation)

Suction -0.50 Cpe

	Height between ties	Width Between Ties	Wind(Sheeted)	Cpe Value	Tie Value (Sheeted)	
Wind pressure +	4	4	0.90	0.85	12.20	kN
Suction -	4	4	0.90	-0.50	-7.18	kN

Netted

	Height between ties	Width Between Ties	Wind(Netted)	Cpe Value	Tie Value (Netted)	
Wind pressure +	4	4	0.54	0.85	7.32	kN
Suction -	4	4	0.54	-0.50	-4.31	kN

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Ref CALCULATION

Unsheeted / Exposed Tube

Number	Member type	Length (m)	Total (m)
0	Standards	0	0
0	Ledger	0	0
0	Ledger Bracing	0	0
0	face Bracing	0	0

0.00 m

Dia. Of Scaffold Tube = 48.3 mm

=> 0.0483 m

Total Area of tube exposed = Dia. Of Scaff. Tube x Total Length of Tube

=> 0.00 m^2

Boards Exposed

Depth of Board (m)	Length (m)	Area (m^2)
0	0	0
0	0	0

T. Area of Board Exp. 0 m^2

Tie Value (No cladding)

Tie $\text{Value}_{(\text{No Cladding})}$ = (Total Tube Area Exp. x 1.2 C_f) + (Total Board Area Exp. x 2 C_f) x Q

=> 0.00 kN

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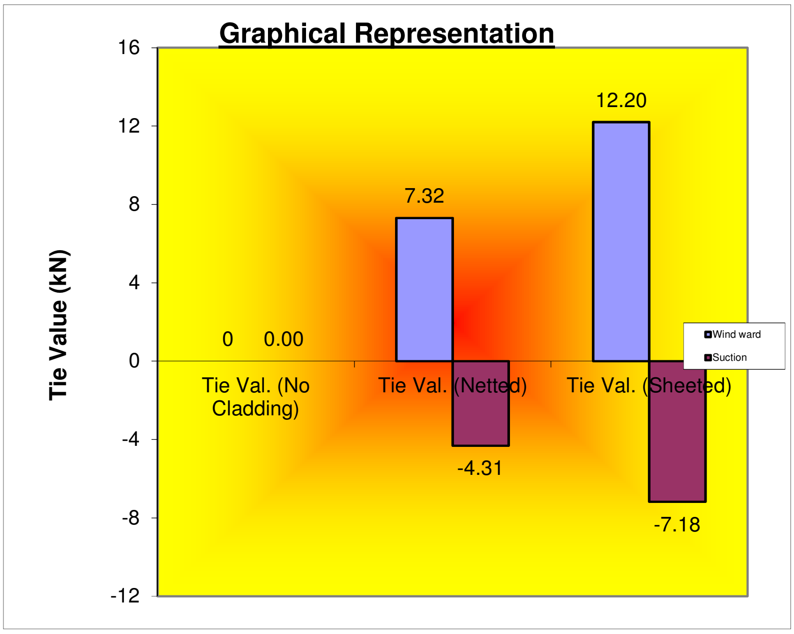
By: **W.A**	***Chkd:***		Date: 20-Sep-17

Ref | CALCULATION

Summary of Tie Results

Face Type	Wind pressure (+)	Suction (-)
Tie Val. (No Cladding)	0	0.00
Tie Val. (Netted)	7.32	-4.31
Tie Val. (Sheeted)	12.20	-7.18



Proof Testing

Proof tests should be carried out in accordance with NASC TG4:05 - Anchorage System for scaffolding. The system should be tested to 1.5 times the required tensile load and at least 5% of the total ties on the job.

Apply factor of safety of 1.5 to wind forces (Wind f. x 1.5)

Tie Val. (No Cladding)	0.00	kN
Tie Val. (Netted)	-6.46	kN
Tie Val. (Sheeted)	-10.76	kN

The required number to be proof tests be at least 3 or 5% of the total number of ties on the job.

Total Ties on the job	44
Percentage of Ties to be tested	5%
Number of Ties to be tested	3

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			Tel: 01273760116 E-mail: info@josephdesign.co.uk
By:	W.A	Chkd:	Date: 20-Sep-17

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Snow Load Calculation

Snow Loading produced in accordance with BS 6399:Part 3, EN 12811 and TG20:08

Snow Load on the Roof

μi = Snow Load Shape Coefficient (in kN/m²) (Clause 7 - BS 6399: Part 3)

So = Site Snow Load (in kN/m²) (Clause 7 - BS 6399: Part 3)

Snow Load on the Ground

Basic Snow Load

Basic snow load (Sb) - (Figure 1 - BS 6399: Part 3)

Site Snow Load

The snow load at the ground level increases as the altitude of the ground level increases. The figures in Figure 1 are for assumed ground level altitudes of 100m. It is only necessary to adjust this value where site altitude is greater than 100m. The site snow load can be calculated as: -

S_o (Site Snow Load) = S_b (Basic snow load)

where the site altitude is **NOT** greater than 100m; **OR**

S_o (Site Snow Load) = S_b + Salt x ((A - 100 / 100)

for sites whose altitude is above 100m but not greater than 500m.

S_b - Basic snow load on the ground (kN/m²) (Figure 1)

Salt - $0.1S_b + 0.09$

A - Altitude of site (in metres)

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By: **W.A**	***Chkd:***		Date: 20-Sep-17

Ref | CALCULATION

<u>Salt Not Greater than 100m</u>

Snow Load (S_d) = μi So

α = 0 Roof Pitch (5°)

μ*i* = 0.8 See figure 2/figure 4(a) in BS 6399
part 3 page 7

S_b = 0.4 Taken from Figure 1, of BS 6399 part 3 page 5

S_d = 0.32 kN/m²

Ref CALCULATION

Maximum safe height of a basic scaffold

Wind factor S is established using the following formula:

=> $$V_b \times T \times \left[1 + \left(\frac{A}{1000}\right)\right]$$

Where

V_b - Basic wind speed

T - Topographical factor

A - Height above sea level

V_b = 21.000 m/s T = 1.36

A = 29.000 m

S = 29.38824

From TG 20:08 Guide to good practice for scaffolding with tube and fittings, Volume 1, Table 3,

Safe heights for Sheeted independent tied scaffolds, Fully ledger braced with lightly

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Job: `091703	Task:	Sheet No: ***12.00***	
By: **W.A**	***Chkd:***		Date: 20-Sep-17

Ref	CALCULATION

Roof Beam check

Uniform distributed Load

positive vertical load = Snow load + self weight   Beam self weight = 0.1

=> 0.42 kN/m^2

Negative vertical load = (wind - self weight) X Cpe

=> -1.43 kN/m^2

where: Cpe value taken from BS 6399 - 2

=> -1.8

Total Load

Span of Roof = 10.00 m

Roof truss centres = 2.00 m

Maximum positive Load = 8.40 kN (W)

Maximum negative Load = -28.69 kN (W)

Maximum Reaction / Shear Force

Maximum positive Shear Force = W/2

=> 4.20 kN

Maximum negative Shear Force = W/2

=> 14.34 kN

Maximum Bending

Maximum Positive Bending = WL/8

=> 10.50 kN.m (M)

Maximum Negative Bending = WL/8

=> 35.86 kN.m (M)

Compression / Tension in chord of beams = M/0.75

=> 47.81 kN

Where: Depth of beam D = 0.75 m

Use x beam restraint at 1 metre interval

Allowable load & applied load

Maximum bending moment =	35.86KNm	Allowable bending moment =	42.9 kN m
Maximum shear force =	14.34 KN	Allowable shear force =	45.4 kN

Scaffold check

Dead Load

Board self weight 0.25 kN/m^2

Imposed Load

Live load 2.00 kN/m^2

Total load 2.25 kN/m^2

Boards

Weight of boards = Width x Span x (Total Load)

Width = 0.225 m

Span = 1.20 m

Total Load = 2.25 kN/m^2

Force applied by Board

= > 0.61 kN

Bending moment = (Force x Span) / 8

= > 0.09 kN.m

Bearing Capacity = **0.48 kN.m**

= > **0.48 kN.m > 0.09kN.m …… OK**

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Job: `091703	Task:	Sheet No: ***15.00***	
By: **W.A**	***Chkd:***		Date: 20-Sep-17

Ref	CALCULATION

Transom

Weight of Transoms = Width x Span x (Total Load)

c/c = 1.20 m

Span = 1.20 m

Total Load = 2.25 kN/m^2

Force applied by Board

= > 3.24 kN

Bending moment = (Force x Span) / 8 (WL/8)

= > 0.49 kN.m

Bearing Capacity = **0.99 kN.m > 0.49kN.m …… OK**

Therefore install transoms at Max. 1200 mm c/c

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Job: `091703	Task:	Sheet No: **16.00**	
By: **W.A**	**Chkd:**		Date: 20-Sep-17

Ref	CALCULATION

Ledger

Force acting on Ledger

= > 1.62 kN

Span = 2.00 m

Bending moment = (Force x Span) / 4 (PL/4)

= > 0.81 kN.m

Bearing Capacity = **0.99 kN.m > 0.81 kN.m …… OK**

Ref | CALCULATION

Standards load

Number of lifts	**9.00**
Number of boarded lifts	**6.00**
Number of main boards	**5.00 (Between standards)**
Number of inside boards	**2.00**
Number of Toe boards	**0.00**
Bay length	**2.00 m**

Inside Standard

Scaffold self Weight

Scaffold self weight calculated at load per lift. This will then be multiplied by number of lifts to obtain a total load.

Number	Member type	Length (m)	Total (m)
1	Standards	2.00	2.00
1	Ledger + Hand R.	2.00	2.00
2	Transoms	1.10	2.2
1	Ledger Bracing	1.16	1.16
1	Face Bracing	0.00	0.00
1	Plan Bracing	0.00	0.00
			5.16 m

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By: **W.A**	***Chkd:***		Date: 20-Sep-17

Ref	CALCULATION

Self weight of scaffold = 0.0437 kN/m

Weight of Tube = Self weight x Total length

= > 0.23 kN

Number of fitting = 7.00 Couplers

Self weight of Coupler = 0.0147 kN (per coupler)

Weight of Coupler = Self weight x Quantity

= > 0.10 kN

Total self weight of scaffold per lift = 0.33 kN

Total self weight of scaffold = 2.96 kN

Board Self Weight

Board Self weight per lift = (No. B. acting on standard + No. inside B.) x B. Width x Bay length x Self w.

No. inside B. = 2.00

No. standard B. = 2.00

Total No. B. Acting on St. = 4.00

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Ref | CALCULATION

Bay Width = 0.225 m

Bay Length = 2.00 m

Self Weight = 0.25 kN/m^2

Board Self weight per lift

=> 0.45 kN (per lift)

Total self weight of Board = 2.70 kN

Imposed load

Total Live load = (No. B. acting on standard + No. inside B.)

x B. Width x Bay length x (Live Load $_{(1)}$ + Live load $_{(2)}$)

No. inside B. = 2.00

No. standard B. = 2.50

Total No. B. Acting on St. = 4.50

Board Width = 0.225 m

Bay Length = 2.00 m

Live load$_{(1)}$ = 2.00 kN/m^2

Live load$_{(2)}$ = 1.00 kN/m^2

Total Live load = 6.08 kN

Total Load

Total inside leg Load = Total Scaffold + Total Board + Total Imposed

=> 11.73 kN

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By: **W.A**	**Chkd:**		Date: 20-Sep-17

Ref | CALCULATION

Number of lifts	**9.00**	
Number of boarded lifts	**6.00**	
Number of main boards	**5.00**	**(Between standards)**
Number of inside boards	**0.00**	
Number of Toe boards	**1.00**	
Bay length	**2.00**	**m**

Outside Standard

Scaffold self Weight

Scaffold self weight calculated at load per lift. This will then be multiplied by number of lifts to obtain a total load.

Number	Member type	Length (m)	Total (m)
1	Standards	2.00	2.00
3	Ledger + Hand R.	2.00	6.00
2	Transoms	0.60	1.20
1	Ledger Bracing	1.16	1.16
1	Face Bracing	1.41	1.41
1	Plan Bracing		
			11.77 m

Site: 31-33 Bloombury Way	**Client:** MW Scaffolding			JOSEPH DESIGN LTD CONSULTING CIVIL & STRUCTURAL
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By: **W.A**	**Chkd:**			Date: 20-Sep-17

Ref	CALCULATION

Self weight of scaffold = 0.0437 kN/m

Weight of Tube = Self weight x Total length

= > 0.51 kN

Number of fitting = 9.00 Couplers

Self weight of Coupler = 0.0147 kN (per coupler)

Weight of Coupler = Self weight x Quantity

= > 0.13 kN

Total self weight of scaffold per lift = 0.65 kN

Total self weight of scaffold = 5.82 kN

Board Self Weight

Board Self weight per lift = (No. B. acting on standard + No. inside B.) x B. Width x Bay length x Self w.

No. toe B. = 1.00

No. standard B. = 2.50

Total No. B. Acting on St. = 3.50

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Ref | CALCULATION

Bay Width = 0.225 m

Bay Length = 2.00 m

Self Weight = 0.25 kN/m^2

Board Self weight per lift

=> 0.39 kN (per lift)

Total self weight of Board = 2.36 kN

Imposed load

Total Live load = (No. B. acting on standard + No. inside B.)

x B. Width x Bay length x (Live Load $_{(1)}$ + Live load $_{(2)}$)

No. toe B. =	0.00	Board Width =	0.225	m
No. standard B. =	2.50	Bay Length =	2.00	m
Total No. B. Acting on St. =	2.50	Live load$_{(1)}$ =	2.00	kN/m^2
		Live load$_{(2)}$ =	1	kN/m^2
		Total Live load =	3.38	kN

Total Load

Total leg Load = Total Scaffold + Total Board + Total Imposed

=> 11.56 kN

Wind to Frame Globally

Beam self weight = 0.15 kN/m^2

(height above last tie)

wind ward C_{pe} = 0.85 Length = 10 m h_1 = 6.2

Suction C_{pe} = -0.5 Beam c/c = 2 m h_2 = 5.3

Snow load = 0.32 kN/m^2 Uplift = -1.43 kN/m^2

Wind Load = 1.06 kN/m^2

Windward

wind ward Load = wind Force x windward Cpe

= > 0.90 kN/m2

Wind ward P1 = 2/3h x bay c/c x Wind ward load

= > 7.41 kN

Wind s.2/3 h_1 (D1) = 4.13 m

Ref CALCULATION

Leeward

Suction Load = wind Force x suction Cpe

= > -0.53 kN/m2

Suction ward P2 = 2/3h x bay c/c x Wind ward load

= > 3.73 kN

W. scaf.2/3 h_2 (D2) = 3.53 m

Uplift globally

Uplift globally (U1) = Length x beam c/c x negat. vertical load

= > 28.69 kN

Wind on scaff.1/2 L (D3) = 5 m

Overturning Moment

Ove. Mo. = (P1 x D1) + (P2 X D2) + (U1 X D3)

=> 187.26 kNm

Apply safety 1.5

=> 280.90 kNm

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By: **W.A**	***Chkd:***		Date: 20-Sep-17

Ref | CALCULATION

Resistance Moment

Total = (Dead + Live)   Roof contribution = 1 kN (say)

Dead = Total - Live

Inside standard = 5.66 kN

Outside standard = 8.18 kN

= 14.84 kN

Lever arm = 10.00 m

=> 148.38 kNm

Force to be resist on ground scaffold

=> (Overturning m. - resisting m.) / lever arm

=> 13.25 kN

=> 1325.18 kg

Therefore add 13.25 KN Kentledge to the each bay

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Axial Load in Compression

BS EN 12811-1 requires a limit state approach for the design of scaffolding and specifies a single partial safety factor of Y_f = 1.5 for loads and a single partial safety factor for resistance of Y_m = 1.1. This allows the use of an approach similar to the permissible stress approach, whereby all loads and all resistances are reduced by dividing them by a single partial safety factor of $Y_f \times Y_m$ = 1.65.

Eurocode 3 (DD ENV 1993-1-1) states that the characteristic compressive strength of a tubular strut, with an effective length is given by: -

N = xAfy

	Type 4 Steel Tube Complying with the requirements of BS EN 39	Type of tube Tube to BS 1139 1982
Outer Diameter (mm)	48.3	48.3
Normal wall thickness (mm)	4	4
Mass per m (kg/m)	4.37	4.37
Cross Sectional Area (cm^2)	5.57	5.57
Moment of inertia (cm^4)	13.8	13.8
Radius of Gyration (cm)	1.57	1.57
Modulus of Elasticity (N/mm^2)	2.1×10^5	2.1×10^5
Flexural Stiffness (N/mm^2)	2.9×10^{10}	2.9×10^{10}
Design Strength (N/mm^2)	235	210
Plastic Module (cm^3)	7.87	7.87
Safe Working Moment (kNm)	1.12	1

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By: **W.A**	**Chkd:**		Date: 20-Sep-17

Ref CALCULATION

N = xAfy

$$x = \frac{1}{\left[Dia + \left[\sqrt{Dia^2 - Lambda^2}\right]\right]}$$

$$Ø = 0.5\left(1 + 0.49(\lambda - 0.2) + \lambda^2\right)$$

$$\lambda = \frac{lambda}{\sqrt{\left(\Pi^2 \, xE / f_y\right)}}$$

$\lambda = L_e / r$

<u>Effective Length in Design</u>

L_e = 2 m

<u>Permissible Compression</u>

$\lambda = \frac{2000}{15.7}$ = 127.39 (slenderness ratio)

$\lambda = \frac{127.39}{93.913}$ = 1.36

Ø = 1.70

X = 0.366

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Job:	`091703	Task: / Sheet No: ***28.00***	
By:	**W.A**	***Chkd:***	Date: 20-Sep-17

Ref	CALCULATION

Therefore N = 47.89 Divide N by safety factor of 1.65

$P_c = \dfrac{47.89}{1.65}$

= **29.02 kN** (For new tube)

Standards load access scaffold

Max.inside leg load

Beam reaction 4.20 KN

Leg load = 15.93 kN

Max outside Leg load

Max. Leg load 11.56 kN

Standards load at tower to support spine beam

24.33 KN Beam Reaction from spine beam 12.60 KN

Bracing the tower will increase bearing capacaty

The bearing capacity of a scaffolding tube of 2.2 m length is 21.6 kN

The bearing capacity of a scaffolding tube of 2.6 m length is 16.60 kN