

Design Calculations

Title: Independent access scaffolding with beam spans

Client: ADT Workspace

Site: Free Trade Exchange, Manchester

Drawing number: 1345

OS Grid: N/A

ELR: N/A

Mileage: N/A

Structure No: N/A

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Date: Tuesday, July 19, 2022

RELEVANT STANDARDS

<u>TG20:21</u>	Guide to good practice for scaffolding with tube & fittings
<u>BS 5975</u>	Code of practice for temporary works procedures & the permissible stress design of falsework
<u>BS:EN 74</u>	Specification for Steel Couplers
<u>BS:EN 39</u>	Specification for Steel Scaffold Tube
<u>BS 1139: 1.2</u>	Specification for Aluminium scaffold Tube
<u>BS 2482</u>	Specification for Timber scaffold boards.
<u>BS:EN 1991-1-1-4</u>	Euro code 1 : Actions on structures
<u>BS:EN 12811-1</u>	Guide to good practice for scaffolding with tubes and fittings

ALLOWABLE BENDING MOMENT & SAFE WORKING LOADS ETC.

	<u>Bending Moment</u>	<u>Shear</u>
Steel Tube	1.12kNm	29.20kN
Aluminium Tube	1.33kNm	25.52kN
Board (225 mm x 38 mm)	0.48 Nm	
Unit Beam	27.70kNm	14.30kN
Ladder Beam	10.4kNm	18.00kN
Apollo. 750mm dp Alloy Beam	42.90kNm	45.5kN
Apollo. 450mm dp Alloy Beam	15.70kNm (laced at 1m c/c)	13.9kN (laced at 1m c/c)
Apollo. 450mm dp Alloy Beam	24.5kNm (laced at 0.5m c/c)	13.9kN (laced at 0.5m c/c)

ALLOWABLE FITTING LOADS.

<u>Type of Fitting</u>	<u>Type of Load</u>	<u>S.W.L (kN)</u>
Right Angle Coupler (Class A)	Slip	6.1
Swivel Coupler (Class A)	Slip	6.1
Girder Coupler	Tension	10
Sleeve Coupler	Tension	3.6

WEIGHT OF MATERIALS ETC.

Steel Tube	=	4.37 kg/m
Aluminium Tube	=	1.67 kg/m
Fittings	=	Various (1kg to 2.25kg)
Board (38 mm Thick)	=	6.00kg/m

Item-

Consider the scaffold boards spanning 1.2m between the transoms

Dead load	Centres	Width	Load						
Boards =	1.2	m	0.225	m	0.250	kN/m ²	=	0.068	kN
Imposed load =	1.200	m	0.225	m	2.000	kN/m ²	=	0.540	kN
Bending moment =	0.068	+	0.540	*	1.200	/	8.00	=	0.091 kNm
Allowable BM for boards = 0.48kNm	0.091	kNm	< 0.48kNm therefore passes						

Consider the scaffold transoms spanning 1m between the ledgers at 1.2m centres

Dead load	Centres	Span	Load						
Boards =	1.200	m	1.000	m	0.250	kN/m ²	=	0.300	kN
Tube =	1.000	m	*		0.043	kN/m ²	=	0.043	kN
Total =	0.300	kN	+		0.043	kN	=	0.343	kN
Imposed load	1.200	m	1.000	m	2.000	kN/m ²	=	2.400	kN
Bending moment =	2.400	kN	*		1.000	/	8.00	=	0.300 kNm
Allowable BM for tube =	0.300	kNm	< 1.12kNm therefore passes						

Consider the scaffold ledgers spanning 2m between standards assuming centre point load

Transom main point load =	0.343	kN	+		2.400	kN	=	2.743	kN
Ledgers are continuous	Span								
Bending moment =	2.000	m	*		2.743	*	0.17	=	0.933 kNm
Allowable BM for tube =	0.933	kNm	< 1.12kNm therefore passes						

STANDARDS

Contractor		ADT Workspace		Drg. Ref.		Standards down to ground				
Site		Free Trade Exchange		Prepared by.		JL	Date		19-Jul-22	
<u>Calculate Axial Load in Standards.</u>			<u>Handrails</u>			<u>Live Load:</u>				
Lift Heights:		2	m.	No.of Lifts with o/s Guardrails		11	1	No. Lifts @	2	kN/m2
Max.No. of Lifts:		11	No.	No.of Lifts with I/s Guardrails		0	0	No. Lifts @	0	kN/m2
Max.No. of Boarded Lifts:		11	No.	No.of Guardrails per Lift.		2	0	No. Lifts @	0	kN/m2
Max.No. of Inside Boards:		2	No.				<u>Additional. Load</u>			
Scaffold Bay Size:		2	m.				Ins. Leg		Outs. Leg	
Width of Scaffold:		1	m.				0	kN.	0	kN
				Inside Leg		Outside Leg	<u>Max. Leg Load.</u>			
							Ins. Leg		Outs. Leg	
No. Lifts requiring double Standards				0		0	13.276	kN.	12.060	

Contractor	ADT Workspace			Drg. Ref.		Front left				
Site	Free Trade Exchange			Prepared by.		JL	Date		19-Jul-22	
Calculate Axial Load in Standards.			Handrails			Live Load:				
Lift Heights:	2	m.	No.of Lifts with o/s Guardrails	10	1	No. Lifts @	2	kN/m2		
Max.No. of Lifts:	10	No.	No.of Lifts with I/s Guardrails	0	0	No. Lifts @	0	kN/m2		
Max.No. of Boarded Lifts:	10	No.	No.of Guardrails per Lift.	2	0	No. Lifts @	0	kN/m2		
Max.No. of Inside Boards:	2	No.				Additional. Load				
Scaffold Bay Size:	1.8	m.				Ins. Leg			Outs. Leg	
Width of Scaffold:	1	m.				0	kN.		0	kN
			Inside Leg			Outside Leg				
							Max. Leg Load.			
							Ins. Leg			Outs. Leg
No. Lifts requiring double Standards			0			0	11.489	kN.		10.342

Contractor		ADT Workspace		Drg. Ref.		Over Cabins		
Site		Free Trade Exchange		Prepared by.		JL	Date	19-Jul-22
<u>Calculate Axial Load in Standards.</u>			<u>Handrails</u>			<u>Live Load:</u>		
Lift Heights:		2	m.	No.of Lifts with o/s Guardrails		9	1	No. Lifts @ 2 kN/m2
Max.No. of Lifts:		9	No.	No.of Lifts with I/s Guardrails		0	0	No. Lifts @ 0 kN/m2
Max.No. of Boarded Lifts:		9	No.	No.of Guardrails per Lift.		2	0	No. Lifts @ 0 kN/m2
Max.No. of Inside Boards:		2	No.				<u>Additional. Load</u>	
Scaffold Bay Size:		2	m.				Ins. Leg	Outs. Leg
Width of Scaffold:		1	m.				0	kN.
			Inside Leg		Outside Leg	<u>Max. Leg Load.</u>		
						Ins. Leg	Outs. Leg	
No. Lifts requiring double Standards			0		0	11.588	kN.	10.270

Contractor		ADT Workspace		Drg. Ref.		Back Street		
Site		Free Trade Exchange		Prepared by.		JL	Date	19-Jul-22
<u>Calculate Axial Load in Standards.</u>			<u>Handrails</u>			<u>Live Load:</u>		
Lift Heights:	2	m.	No.of Lifts with o/s Guardrails	10	1	No. Lifts @	2	kN/m2
Max.No. of Lifts:	10	No.	No.of Lifts with I/s Guardrails	0	0	No. Lifts @	0	kN/m2
Max.No. of Boarded Lifts:	10	No.	No.of Guardrails per Lift.	2	0	No. Lifts @	0	kN/m2
Max.No. of Inside Boards:	2	No.				<u>Additional. Load</u>		
Scaffold Bay Size:	2	m.				Ins. Leg		Outs. Leg
Width of Scaffold:	1	m.				0	kN.	0 kN
			Inside Leg		Outside Leg	<u>Max. Leg Load.</u>		
						Ins. Leg		Outs. Leg
No. Lifts requiring double Standards			0		0	12.439	kN.	11.172

Beams

Loadings and reactions on 750mm lattice Beams- Front Left

Beam spans- Multiple point load (using Equivalent Uniform loads)

Type of beam-	750 mm				
Laced at	1 m		300 mm	Ladder	
			450 mm	Apollo	
Span	5.4 m		450.5 mm	Apollo	
			750 mm	Apollo	
No of equally spaced loads	2		780 mm	Layher	
			750 mm	Haki	
Load at 1 point	11.48 kN			Factor	
BM	20.69 kNm	<	42.90	Therefore	PASSES
Shear	11.48 kN	<	45.50		PASSES

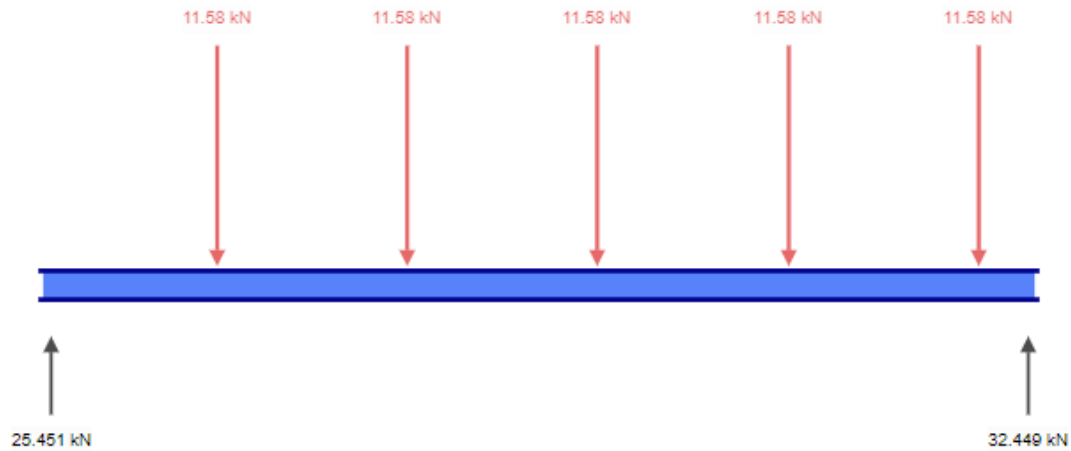
Loadings and reactions on 450mm lattice Beams- Back Street

Beam spans- Multiple point load (using Equivalent Uniform loads)

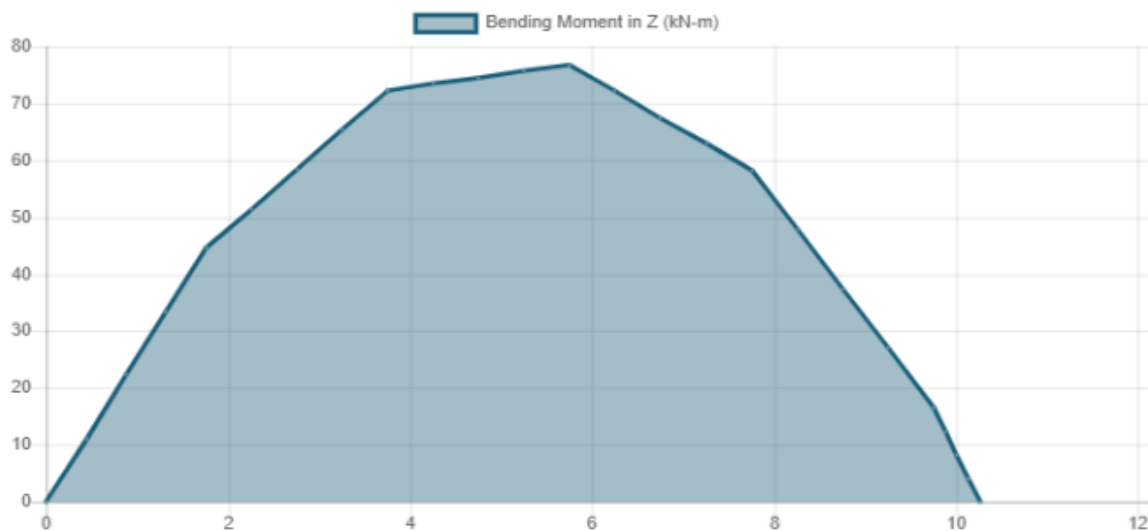
Type of beam-	450 mm				
Laced at	1 m		300 mm	Ladder	
			450 mm	Apollo	
Span	3.6 m		450.5 mm	Apollo	
			750 mm	Apollo	
No of equally spaced loads	1		780 mm	Layher	
			750 mm	Haki	
Load at 1 point	11.48 kN			Factor	
BM	10.33 kNm	<	15.70	Therefore	PASSES
Shear	5.74 kN	<	13.90		PASSES

Loadings and reactions on 750mm lattice Beams- Over Cabins

- Max reaction/shear
32.45kN < 45.5kN therefore **passes**



- Max BM
76.86kNm < 42.9kNm therefore **USE DOUBLE BEAMS**



Loads from wind

Wind Loads- as TG20, TG9:10 Appendix E, EN 12811 and NA to BS EN 1991-1-4:2005

(Appendix E to be used with scaffolds < 100m high with no significant topo or < 50m with significant topo)

Distance from edge of Town	<2	in km	Cc	2.2	Table E 1 (combination)
Significant Topography	n	y or n	Vb.map	22.5	Fig E 1 App E
Altitude above sea- A	50	in m	Cdir	1	Table NA.1 page 4
Cprob- do not use twf if <1	1		Cseason	1	Table NA.2 page 6
			Twind	1	Fig E 3

1) Peak Wind Pressure $Q_p = 0.613 \cdot C_c \cdot S_{wind}^2$ Appendix E

2) $S_{wind} = T_{wind} \cdot V_{map} \cdot (1 + 0.001 \cdot A) \cdot C_{prob} \cdot C_{dir} \cdot C_{season}$ Appendix E

3) $S_{wind} = 23.63$

4) $Q_p = 0.75 \text{ kN/m}^2 \cdot 0.70 \text{ tw factor} = 0.53 \text{ kN/m}^2$

Wind Load per tie/m²

	(Cpe for sheeting-Cpe*1, for debris netting Cpe*0.5, for unsheeted Cpe *0.21)		
Ae- Max Area acting on 1 tie	8.00	in m ²	1
Qp=	0.53	kN/m ²	
Cpe +ve=	1.2		ind-TG20 page 150, sign-7.4.3 EN 1991, net cpe 2walls- NA4
Cpe -ve	1.2		

1) Load = $Q_p \cdot A_e \cdot C_f$

2) Therefore max push in= 5.06 kN sf 1.25

3) Therefore max pull out= 5.06 kN test to 6.32 kN

Table E1: Combined exposure factor, Cc

Height Z – h _{dis} ** (m)	Site in country or adjacent to sea				Site in town, more than 2 km from the edge of the town		
	Closest distance to the shoreline (km)				Distance to shoreline (km)		
	≤ 0.1	2	10	≥ 100	≥ 2	10	≥ 100
≤ 2	1.90	1.60	1.50	1.40	1.07	1.01	0.94
3	2.15	1.84	1.73	1.62	1.32	1.25	1.17
4	2.31	2.03	1.90	1.78	1.54	1.44	1.35
5	2.43	2.18	2.05	1.90	1.72	1.62	1.50
10	2.82	2.65	2.50	2.32	2.33	2.20	2.04
15	3.07	3.02	2.85	2.67	2.81	2.65	2.48
20	3.20	3.05	2.98	2.78	2.90	2.83	2.64
30	3.42	3.43	3.27	3.04	3.40	3.24	3.01
50	3.68	3.68	3.62	3.39	3.68	3.62	3.39
100	3.98	3.98	3.98	3.80	3.98	3.98	3.80

Notes: (1) Interpolation may be used in this table
(2) Based on Figure NA.7 and Figure NA.8 in the NA to BS EN 1991-1-4

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.

NA.2.7 Season factor, c_{season} [BS EN 1991-1-4:2005, 4.2 (2)P Note 3]

The season factor c_{season} is given in Table NA.2.

Table NA.2 Season factor c_{season}

Months	1 month	2 months	4 months
January	0,98		
February	0,83	0,98	
March	0,82		0,98
April	0,75	0,83	0,87
May	0,69		
June	0,66	0,71	
July	0,62		0,73
August	0,71	0,71	0,83
September	0,82		
October	0,82	0,85	0,86
November	0,88		
December	0,94	0,95	0,96
January	0,98		1,00
February	0,83	0,98	
March	0,82		

NOTE 1 The factor for the six month winter period October to March inclusive is 1,00 and for the six month summer period April to September inclusive is 0,84.

NOTE 2 These factors provide the 0,02 probability of exceedance for the period given (see 3.4).

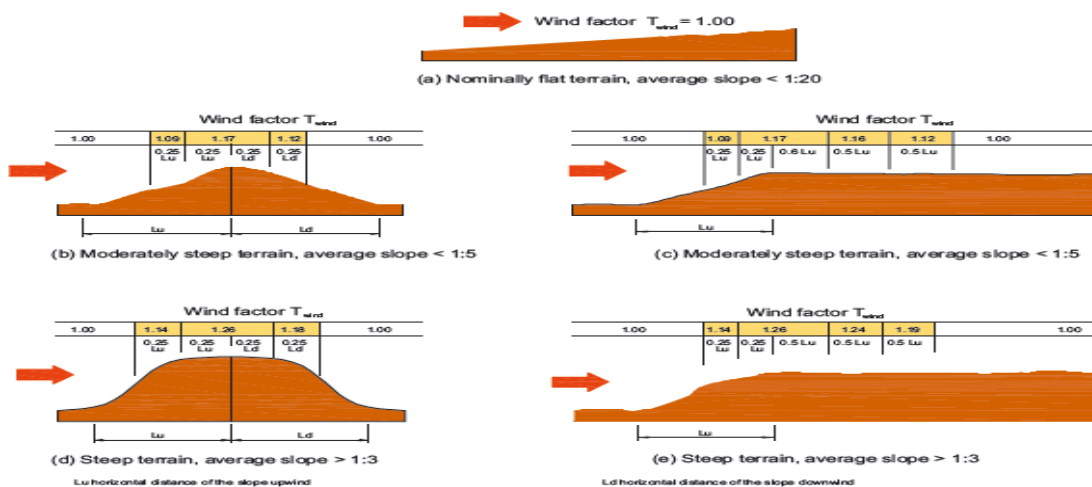


Figure E.2 – Topography factor, T_{wind}



Figure E.3 – Displacement height

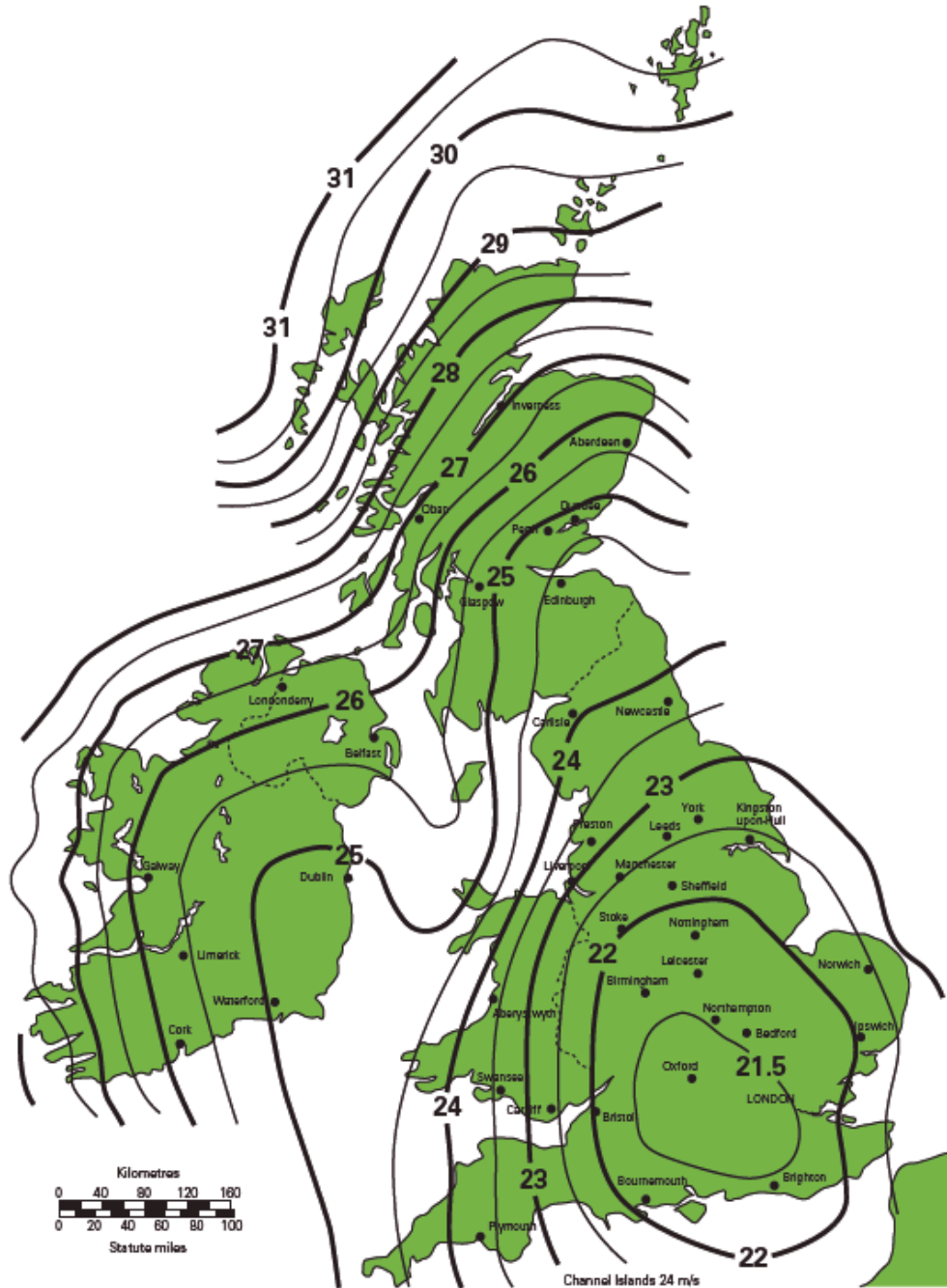


Figure E.1 – Wind speed, V_{map} (m/s)