

Supporting Calculations



BDS | SCAFFOLD
DESIGN
SPECIALISTS

Drawn By: Alex Murphy		
Date: 05/10/2023		
Calculations By: Jonny Hollingworth	Client: Connolly Scaffolding Ltd	Drawing Status: APPROVAL
Date: 05/10/2023	Project: Various Throughout England & Wales	Drawing Ref: BDS - 10476 - 01
Checked By: Mike Brown	Drawing Title: Edge Protection To Shaft Opening	Revision: N/A
Date: 05/10/2023		Pages: N/A

Components & Material Properties

Items listed below are for information purposes only, & are not necessarily used in this design.

All tubes used in this design are based on type 4, unless otherwise stated.

All couplers used in this design are based on class "B", unless otherwise stated.

NASC TG20:21 - Page 119 - Table 5.9Steel Tube (Type 4)

Area	=	5.57cm ²
Wall Thickness	=	4mm
Self Weight	=	4.37kg/m (0.043kN/m)
Diameter	=	48.3mm
Radius of Gyration	=	1.57cm
Plastic Modulus	=	7.87cm ³
Design Strength	=	235N/mm ²
Modulus of Elasticity	=	210000N/mm ²
Moment of Inertia	=	13.8cm ⁴
Moment Capacity	=	1.12kNm
Shear Capacity	=	29.1kN

NASC TG20:21 - Page 121 - Table 5.10

<u>Effective Length (L_E)</u>	<u>Slenderness ratio - λ</u>	<u>Safe axial load -P_c</u>
1.0m	63.50	58.60kN
1.1m	70.00	55.25kN
1.2m	76.50	51.90kN
1.3m	82.70	48.60kN
1.4m	88.90	45.30kN
1.5m	95.30	42.25kN
1.6m	101.70	39.20kN
1.7m	108.05	36.45kN
1.8m	114.40	33.70kN
1.9m	120.75	31.40kN
2.0m	127.10	29.10kN
2.1m	133.45	27.20kN
2.2m	139.80	25.30kN
2.3m	146.15	23.65kN
2.4m	152.50	22.00kN
2.5m	158.85	20.65kN
2.6m	165.20	19.30kN
2.7m	171.55	18.20kN
2.8m	177.90	17.10kN
2.9m	184.25	16.15kN
3.0m	190.60	15.20kN
3.1m	196.95	14.40kN
3.2m	203.30	13.60kN
3.3m	209.65	12.90kN
3.4m	216.00	12.20kN

<u>Effective Length (L_E)</u>	<u>Slenderness ratio - λ</u>	<u>Safe axial load - P_c</u>
3.5m	222.35	11.60kN
3.6m	228.70	11.00kN
3.7m	235.05	10.50kN
3.8m	241.40	10.00kN
3.9m	247.75	9.55kN
4.0m	254.10	9.10kN

NASC TG20:21 - Page 129 - Table 5.14

Effective lengths, L_E of standards in ledger braced tied independent scaffolds with 2m lifts with effective façade bracing

Vertical intervals betv Bay lengths

lines of ties	1.2m	1.5m	1.8m	2.0m	2.1m	2.4m	2.7m
2m with 2m 1st lift	2.5	2.5	2.5	2.5	2.55	2.75	2.9
2m with 2.7m 1st lift	2.7	2.7	2.7	2.7	2.7	2.9	3
4m	3.2	3.2	3.2	3.2	3.2	3.2	3.2
6m	4	4	4	4	4	4	4

NASC TG20:21 - Page 166 - Table C1

Aluminium Tube

Area	=	6.15cm ²
Wall Thickness	=	4.47mm
Self Weight	=	1.65kg/m
Diameter	=	48.3mm
Radius of Gyration	=	1.56cm
Plastic Modulus	=	8.61cm ³
Design Strength	=	255N/mm ²
Modulus of Elasticity	=	70000N/mm ²
Moment of Inertia	=	14.9cm ⁴
Moment Capacity	=	1.33kNm

NASC TG20:21 - Page 167 - Table C.2

<u>Effective Length (L_E)</u>	<u>Slenderness ratio - λ</u>	<u>Safe axial load - P_c</u>
1.0m	64.2	48.90kN
1.2m	77	36.60kN
1.4m	89.9	27.90kN
1.6m	102.7	21.80kN
1.8m	115.5	17.50kN
2.0m	128.4	14.40kN
2.2m	141.2	12.00kN
2.4m	154	10.10kN
2.6m	166.9	8.70kN
2.8m	179.7	7.50kN

NASC TG20:21 - Page 135 - Table 5.15**Couplers**

Right Angle Coupler (Double) Class "A"	SWL =	6.10kN	Slip
Right Angle Coupler (Double) Class "B"	SWL =	9.10kN	Slip
Band & plate (Double) coupler	SWL =	6.10kN	Slip
Right Angle Coupler (Double) Self Weight	SW =	1.25kg	
Swivel Coupler Class "A"	SWL =	6.10kN	Slip
Swivel Coupler Class "B"	SWL =	9.10kN	Slip
Swivel Coupler Self Weight	SW =	1.33kg	
Sleeve Coupler Class "A"	SWL =	3.60kN	Tension
Adjustable Screw Jack (200mm extension)	SWL =	35.00kN	Compression
Girder Coupler (must be used in pairs)	SWL =	10.00kN	"X" Axis
	SWL =	30.00kN	"Y" Axis
	SWL =	12.50kN	"Z" Axis
Girder Coupler Self Weight (each)	SW =	1.50kg	

Timber Scaffold Boards

Self Weight	=	25kg/m ²
Width	=	225mm
Thickness	=	38mm
Section Modulus	=	47.5cm ³
Moment Capacity	=	0.48kNm

300mm Ladder Beams* (Steel) Laced at 1m c/c

Self Weight	=	0.30kN	(laced & braced)
Moment Capacity	=	10.40kNm	
Shear Capacity	=	18.00kN	

*For further information refer to manufacturer

RMD Superslim Soldiers

Moment Capacity	=	38.0kNm
Shear Capacity	=	75.0kN

*For further information refer to manufacturer

450mm Apollo Beams* (Aluminium) Laced at 1m c/c

Self Weight	=	0.14kN	(laced & braced)
Moment Capacity	=	15.70kNm	
Shear Capacity	=	13.90kN	

*For further information refer to manufacturer

750mm Apollo Beams* (Aluminium) Laced at 1m c/c

Self Weight	=	0.28kN	(laced & braced)
Moment Capacity	=	42.90kNm	
Shear Capacity	=	45.50kN	

*For further information refer to manufacturer

1300mm Apollo Beams* (Aluminium) Laced at 1m c/c

Self Weight	=	Varies TBC	(laced & braced)
Moment Capacity	=	98.52kNm	
Shear Capacity	=	44.25kN	

*For further information refer to manufacturer

1500mm Apollo Beams* (Aluminium) Laced at 1m c/c

Self Weight	=	Varies TBC (laced & braced)
Moment Capacity	=	255.00kNm
Shear Capacity	=	60.00kN

*For further information refer to manufacturer

1300mm Asterix Beams* (Aluminium)

Self Weight	=	Varies TBC (laced & braced)
Moment Capacity	=	102.20kNm Laced at 1m c/c
Moment Capacity	=	77.70kNm Laced at 1.5m c/c
Shear Capacity	=	42.10kN (Top & Bottom chords connected)
Shear Capacity	=	32.60kN (Bottom chord connected)

*For further information refer to manufacturer

450mm Layher Beams* (Aluminium) Laced at 1m c/c

Self Weight	=	0.14kN (laced & braced)
Moment Capacity	=	13.94kNm
Shear Capacity	=	12.32kN

*For further information refer to manufacturer

450mm Layher Beams* (Aluminium) Laced at 1.5m c/c

Self Weight	=	0.14kN (laced & braced)
Moment Capacity	=	8.06kNm
Shear Capacity	=	12.32kN

*For further information refer to manufacturer

450mm Layher Beams* (Aluminium) Laced at 2m c/c

Self Weight	=	0.14kN (laced & braced)
Moment Capacity	=	5.14kNm
Shear Capacity	=	12.32kN

*For further information refer to manufacturer

780mm Dessa Beams* (Aluminium) Laced at 1m c/c. (6no. bolts 3 each side of spigot)

Self Weight	=	0.28kN (laced & braced)
Moment Capacity	=	38.84kNm
Shear Capacity	=	23.71kN

*For further information refer to manufacturer

Relevant Design Standards/guidance (only a selection of the below standards are applicable for this design)

BS EN 39	:2001	Specification for steel scaffold tube.
BS EN 74-1	:2005	Couplers, spigot pins & baseplates for use in falsework & scaffolds.
BS EN 12811-1	:2003	Temporary works equipment: Scaffolds - Performance requirements & general design.☐
BS EN 12812-1	:2008	Falsework: Performance requirements & general design.
BS EN 1139-1-2	:1990	Metal scaffolding - part 1: Tubes - Specification for aluminium tube.
BS EN 1139-2-2	:2009	Metal scaffolding - part 2: Couplers - Specification for aluminium couplers.
BS EN 1991-1-1	:2002	Eurocode 1: Actions on structures - Densities, self-weight & imposed loads.
BS EN 1991-1-3	:2003	Eurocode 1: Actions on structures - Snow loads.
BS EN 1991-1-4	:2005	Eurocode 1: Actions on structures - Wind loads.
BS EN 1991-2	:2003	Eurocode 1: Actions on structures - Part2: Traffic load and bridges
BS EN 13374	:2013	Temporary edge protection systems - Product specification, test methods.
BS 5975	:2019	Code of practise for temporary work procedures & the p design of false work.
BS 2482	:2009	Specification for timber scaffold boards.
TG3:19		Erection, use & dismantling of temporary rubbish chutes on scaffold.
TG4:19		Anchorage systems.
TG9:18		Guide to the design & construction of temporary roofs & buildings.
TG12:17		Tying down of scaffold boards.
TG13:16		Non-standard boarded platforms.
TG16:21		Anchoring to the ground.
TG20:21		Technical guidance on the use of BS EN 12811-1.
SG4:15		Preventing falls in scaffolding.
SG5:18		Overhead power sources.
SG25:20		Access & egress from scaffolds.
SG27:09		Temporary edge protection on open steelwork.
SG28:17		Safe system of work for scaffolding associated with timber frame building construction.
SG29:17		Internal edge protection on scaffold platforms.
SG32:17		Provision of extended & telescopic transoms & board brackets.
SG34:17		Guidance on protection of the public

Job Description: Edge Protection To Shaft Opening

Safe Working Loads: Class "A" Edge Protection (Vertical) at: 1.25 kN
 Class "A" Edge Protection (Horizontal) at: 0.3 kN

Item: Edge Protection

Max Bay Length: 2.70m
 Max Handrail Spacing: 0.50m
 Max Transom Centres: N/A
 Max Standard Load: N/A

Item: Loading Bay

Max Bay Length: N/A
 Max Bay Width: N/A
 Max Transom Centres: N/A
 Max Standard Load: N/A

Item: Birdcage

Max Bay Length: N/A
 Max Bay Width: N/A
 Max Transom Centres: N/A
 Max Standard Load: N/A

Item: Buttress

Max Bay Length: N/A
 Max Bay Width: N/A
 Max Transom Centres: N/A
 Max Standard Load: N/A

Item: Ties (Tension)

Max Tie Load: N/A
 Preliminary Test: N/A
 Proof Test: N/A

Item: Ties (Shear)

Max Tie Load: 0.63kN
 Preliminary Test: N/A
 Proof Test: N/A

Additional Comments (if required)

- Preliminary & proof tests not required .
- Edge protection internally founded and not subject with wind. Therefore no further analysis required & edge protection deemed stable.

Item: Class A Edge Protection**4 Classification of edge protection systems****4.1 Class A**

Class A protection provides resistance to static loads only, based on the requirements to:

- support a person leaning on the protection or provide a handhold when walking beside it; and
- arrest a person who is walking or falling towards the protection.

5.1.3 Principal guardrail

The distance between the uppermost part of the edge protection and the working surface shall be at least 1,0 m measured perpendicular to the working surface, see Figures 4 .

5.1.4 Toeboard

The upper edge of the toeboard shall be at least 150 mm above the working surface, see Figures 4 and 5.

The toeboard should be designed to avoid gaps between it and the working surface on normally a flat working surface.

If there are gaps, a sphere with a diameter of 20 mm shall not pass through them.

NOTE For other situations for example where the working surface is not flat, any gaps should be maintained as close as practicable to this figure

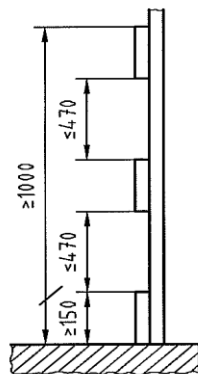


Figure 4 — Limiting dimensions for class A edge protection

6.3.1.1 General

Each edge protection and each of its components, except toeboards, shall be designed to withstand a load $F_{H1} = 0,3 \text{ kN}$ applied perpendicular to the axis of the post, see Figure 6.

6.3.6 Accidental loading

Any guardrail or intermediate guardrail or toeboard, regardless of its method of support, shall be capable of resisting a downwards point load $F_D = 1,25 \text{ kN}$ on a length of 100 mm. This also applies to any other component of the edge protection systems, such as a fencing structure, which has gaps in excess of 100 mm width, see Figure 6.

This load shall be applied in the most unfavourable position of the edge protection system in a downward direction within a sector of $\pm 10^\circ$ from the vertical.

Loading and Reactions on Edge Protection (Centre Point Loading)

Vertical Load:	1.25kN	Bay Lengths:	2.70m
Horizontal Load:	0.30kN	Puncheon/Standard Length:	0.00m
Tube Dead Load:	0.043kN/m	Coupler Dead Load:	0.018kN
No. of Rails:	1	Number of Couplers per Frame:	2
Length of Bracing:	0.00m	Length of Transoms/Needles:	0.00m

Max Reaction/Shear

Weight	*	No. PL's	/	2	=	Reaction
1.25kN	*	1	/	2	=	0.625kN

Support

1	0.63kN	<	29.1kN
2	0.63kN	<	29.1kN

PASSES
PASSES

Max Bending Moment

Weight	*	Length	/	4	=	BM	(CPL)
1.25kN	*	2.70m	/	4	=	0.84kNm	

Bending Moment at	1.35m	Bending Moment	=	0.84kNm	<	1.12kNm	PASSES
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Consider Imposed Load From Edge Protection

Dead Load

Dead load of handrails	=	0.12kN
Dead load of Puncheon/Standard	=	0.00kN
Dead load of Transom/Needle	=	0.00kN
Dead load of Bracing	=	0.00kN
Dead load of Couplers	=	0.04kN

<u>Live Load</u>	=	0.00kN
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<u>Total Load</u>	=	0.15kN
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Consider Shear Tie Capacity

Load	*	FOS	=	Total Load	<	Capacity	Result
0.63kN	*	1.5	=	0.94kN	<	15.00kN	PASSES

Setting Details		5x30	5x50	5x75	5x100	6x50	6x75	6x100	6x130	6x150	8x60	8x75	8x100	8x130	8x150	10x60	10x75	10x100	10x130	10x150	12x75	12x100	12x130	12x150	12x200	16x100	16x150	16x200
d0	Drill Diameter	5				6					8					10					12					16		
l	Anchor Length	30	50	75	100	50	75	100	130	150	60	75	100	130	150	60	75	100	130	150	75	100	130	150	200	100	150	200
tfix	Maximum Fixing Thickness	5	25	50	63	20	45	55	85	105	20	35	60	90	110	10	25	50	80	100	15	40	70	90	140	20	70	120
hmin	Minimum Embedment	25				30					40					50					60					80		
h1	Minimum Hole Depth	35				40					55					70					85					115		
tinst	Installation Torque (Nm)	15				25					40					60					80					100		
Num	Mean Ultimate Tensile Action (kN)	4.2				8					12					18					26					40		
Vum	Mean Ultimate Shear Action (kN)	9				10					24					40					54					N/A		
Nrec	Maximum Allowable Tensile Action (kN)	2.1				4					3					4.5					6.5					8		
Vrec	Maximum Allowable Shear Action (kN)	4.5				2.5					6					10					13.5					N/A		
AF	A/F Size	8				10					15					17					19					27		
H2	Washer Diameter	N/A				N/A					10					12					14					18		
	Normal Edge Distance (Tensile)	N/A				60					60					80					90					100		
	Normal Edge Distance (Shear)	N/A				80					90					120					140					N/A		
	Normal Spacing Distance (Tensile)	N/A				100					120					170					200					220		

Project:	Various Throughout England & Wales
Drawing Number:	BDS - 10476 - 01
Item:	Edge Protection To Shaft Opening
Revision (if applicable):	N/A
Category of Check (1, 2, or 3):	2

Description of Temporary Works:

Edge Protection To Shaft Opening

I certify for and on behalf of BDS Ltd, that in my opinion, the erection proposals and proposed temporary works details, specified in the schedule attached hereto relating to the construction of the above contract, are satisfactory for the proper discharge of responsibilities for the safe temporary works design elements of the works, and for their safe execution and removal (if applicable) in accordance with the drawings and specification, and without detriment to the related permanent Works.

Schedule of Drawings and Other Documents:

10476 - 01 Double Handrail & Toe Board
 Triple Handrail & Toe Board
 Double Handrail With A 150mm Upstand
 Triple Handrail With A 150mm Upstand

Supporting Calculations: Page 1 to 10
 Check Certificate: Page 11 of Calculations Document

Drawn By: Alex Murphy
 Company: Buckley Design Solutions

Signature:



Drawing Status:
APPROVAL

Calculations By: Jonny Hollingworth
 Company: Buckley Design Solutions

Signature:



Checked By: Mike Brown
 Company: Buckley Design Solutions

Signature:



Date:
 05/10/2023