

Revision A: Supporting Calculations



BDS | SCAFFOLD
DESIGN
SPECIALISTS

Drawn By: Hayden Allan		
Date: 24/11/2023		
Calculations By: Brad Charles	Client: Connolly Scaffolding Ltd	Drawing Status: CONSTRUCTION
Date: 24/11/2023	Project: Rylands, Manchester	Drawing Ref: BDS - 10636 - 01 to 02
Checked By: Mike Brown	Drawing Title: High Level Access Platform & Back Propping	Revision: A 24/11/2023
Date: 24/11/2023		Pages: All

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_F)</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_F 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_F)</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: High Level Access Platform & Back Propping

Safe Working Loads: Access Platform with 1no. Lift at: 10 kN/m²

Item: Access Platform

Max Bay Length: 1.50m
Max Bay Width: 0.95m (4 bds)
Max Transom Centres: 0.75m
Max Standard Load: Refer to DWG's

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: Lip Tie

Max Tie Load: 4.23kN
Preliminary Test: N/A
Proof Test: N/A

Item: Ties (Shear)

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

Additional Comments (if required)

Item: **Access Platform** Y

Bay Lengths (m)	Bay Widths (m)	Transom C/C (m)	No. Inside Boards	SWL (kN/m ²)
1.5	0.95	0.75	0	12.5

Dynamic Load Applied (25%) Board Dead Load (kN/m²)

YES

0.25

Consider Scaffold Boards Spanning

Dead Load	Centres	Width	Load	Results
Boards	0.75 m	0.225 m	0.25 kN/m ²	(kN) = 0.042
Imposed Loads	0.75 m	0.225 m	12.5 kN/m ²	(kN) = 2.109
Bending Moment	0.042	+ 2.109	X 0.75 /8	(kNm) = 0.202
Allowable Bending Moment For Scaffold Boards = 0.48kNm				(kNm) > 0.202

PASSES

Transoms With No Inside Boards

Consider The Transoms Spanning

Dead Load	Centres	Span	Load	Results
Boards	0.75 m	0.95 m	0.25 kN/m ²	(kN) = 0.178
Tube	0.95 m	X	0.043 kN/m	(kN) = 0.041
Total	0.178 kN	+	0.041 kN	(kN) = 0.219
Imposed Load	0.75 m	0.95 m	12.5 kN/m ²	(kN) = 8.906
Non-cantilevered Transom BM as TG20:21 - section 5.11.1.1 - $M = 0.125 \times W \times L$ (kNm)				
Bending Moment	0.125	9.13 kN	0.95 m	(kNm) = 1.084

Allowable Bending Moment For Scaffold Tube = **1.12kNm** (kNm) > **1.084**

PASSES

Transoms With Inside Boards

Consider The Transoms Spanning

Dead Load	Centres	Span	Load	Results
Boards	0.75 m	0 m	0.25 kN/m ²	(kN) = 0.000
Tube	0 m	X	0.043 kN/m	(kN) = 0.000
Total	0.000 kN	+	0.000 kN	(kN) = 0.000
Imposed Load	0.75 m	0 m	0.75 kN/m ²	(kN) = 0.000
Cantilevered Transom BM as TG20:21 - section 5.11.1.2 - $M_c = 0.5 \times W_c \times L_c$ (kNm)				
Bending Moment	0.5	0.00 kN	0 m	(kNm) = 0.000

Allowable Bending Moment For Scaffold Tube = **1.12kNm** (kNm) > **0.000**

PASSES

Continuous Transoms e.g. Birdcage**Consider The Transoms Spanning**

Dead Load	Centres	Span	Load	Results	
Boards	0.75 m	0.95 m	0.25 kN/m ²	(kN) =	0.178
Tube	0.95 m	X	0.043 kN/m	(kN) =	0.041
Total	0.178 kN	+	0.041 kN	(kN) =	0.219
Imposed Load	0.75 m	0.95 m	12.5 kN/m ²	(kN) =	8.906
Continuous Transom BM as TG20:21 - section 5.11.1.3 - $M = 0.086 \times W \times L$ (kNm)					
Bending Moment	0.086	9.13 kN	0.95 m	(kNm) =	0.746
Allowable Bending Moment For Scaffold Tube = 1.12kNm				(kNm) >	0.746

PASSES**Simply Supported Ledger****Consider The Ledger Spanning**

Transom Point Load		1.5 m			
		9.13 kN			
Simply supported ledger as TG20:21 - section 5.12.1.1 - $M = 0.25 \times P \times L$ (kNm)					
Bending Moment	0.25	9.13 kN	1.5 m	(kNm) =	3.422
Allowable Bending Moment For Scaffold Tube = 1.12kNm				(kNm) >	3.422

FAILS**Refer To Comments Below****Continuous Ledger****Consider The Ledger Spanning**

Transom Point Load		1.5 m			
		9.13 kN			
Continuously supported ledger as TG20:21 - section 5.12.1.2 - $M = 0.167 \times P \times L$ (kNm)					
Bending Moment	0.167	9.13 kN	1.5 m	(kNm) =	2.286
Allowable Bending Moment For Scaffold Tube = 1.12kNm				(kNm) >	2.286

FAILS**Refer To Comments Below****Part Continuous Ledger (end bay)****Consider The Ledger Spanning**

Transom Point Load		1.5 m			
		9.13 kN			
Part continuous supported ledger as TG20:21 - section 5.12.1.2 - $M = 0.172 \times P \times L$ (kNm)					
Bending Moment	0.172	9.13 kN	1.5 m	(kNm) =	2.354
Allowable Bending Moment For Scaffold Tube = 1.12kNm				(kNm) >	2.354

FAILS**Refer To Comments Below**

Additional Platform Check Comments (if required)

Simply supported ledgers not applicable within this item.

750mm Beams Used As Ledgers

INSIDE STANDARD

Allowance For Double Width: N/A

Tube DL (kN/m)	0.043	Boards DL (kN/m ²) (kN/m)	0.25 0.056	Fittings (kN)	0.018	Length (m)	Width (m)	Quantity	Length (or) Area
Bay Size						0.95m	0.51m		
Standards (lift height)								3	1.50m
Ledgers								1	0.95m
Beam							kN/m	0	0.95m
Transom								1	0.26m
Guardrails								2	0.95m
Boarded (Main Platform)								1	0.24
Boarded (Inside Boards)								0	0.00
Toe Boards								0	0.95m
Ledger Bracing								0	1.91m
Façade Bracing								0	2.13m
Plan Bracing								0	1.63m
Fittings								4	N/A
Live Loads Applied				Total Number of Lifts:				1	
				Number of Boarded Lifts:				0	
(SWL) 100%		0.00kN /m ²		Total Dead Load Per Lift:					0.40kN
(SWL) 50%		0.00kN /m ²		Total Dead Load					0.40kN
(SWL) Inside bds		0.00kN /m ²							
Maximum No. Lifts at 100%		1		Total Live Load:					0.00kN
Maximum No. Lifts at 50%		0							
No. Lifts with inside bds loaded		1		Total Load Combined:					0.40kN
No. Support Stds/Puncheons		1							
Axial Load	Effective Length (Le)	Safe Axial Load (Pc)	Slenderness Ratio (λ)	Slenderness Max (λ)	Result				
0.40kN	3.2 m	13.60kN	203.3	271	PASSES				

Ground Bearing Pressure (GBP)

		Sole Pad Arrangements		
		Pad Width (m)	Pad Length (m)	Pad Area (sqm)
Typical Arrangement	y	0.225	0.450	0.10125
Increased Arrangement		0.450	0.450	0.2025
Tredda Plate		0.210	0.210	0.0441
Other				0
Imposed Load:	0.40 kN			
GBP:	3.94 kN/m ²			

Additional Comments If Required

INSIDE STANDARD

Allowance For Double Width: N/A

Tube DL (kN/m)	0.043	Boards DL (kN/m ²) (kN/m)	0.25 0.056	Fittings (kN)	0.018	Length (m)	Width (m)	Quantity	Length (or) Area
Bay Size						0.95m	0.23m		
Standards (lift height)								2	1.50m
Ledgers								1	0.95m
Beam							kN/m	0	0.95m
Transom								1	0.12m
Guardrails								2	0.95m
Boarded (Main Platform)								1	0.11
Boarded (Inside Boards)								0	0.00
Toe Boards								0	0.95m
Ledger Bracing								1	1.77m
Façade Bracing								1	2.13m
Plan Bracing								0	1.49m
Fittings								6	N/A
Live Loads Applied				Total Number of Lifts:				1	
				Number of Boarded Lifts:				0	
(SWL) 100%		0.00kN /m ²		Total Dead Load Per Lift:					0.53kN
(SWL) 50%		0.00kN /m ²		Total Dead Load					0.53kN
(SWL) Inside bds		0.00kN /m ²							
Maximum No. Lifts at 100%		1		Total Live Load:					0.00kN
Maximum No. Lifts at 50%		0							
No. Lifts with inside bds loaded		1		Total Load Combined:					0.53kN
No. Support Stds/Puncheons		1							
Axial Load	Effective Length (Le)	Safe Axial Load (Pc)	Slenderness Ratio (λ)	Slenderness Max (λ)	Result				
0.53kN	3.2 m	13.60kN	203.3	271	PASSES				

Ground Bearing Pressure (GBP)

		Sole Pad Arrangements		
		Pad Width (m)	Pad Length (m)	Pad Area (sqm)
Typical Arrangement	y	0.225	0.450	0.10125
Increased Arrangement		0.450	0.450	0.2025
Tredda Plate		0.210	0.210	0.0441
Other				0
Imposed Load:	0.53 kN			
GBP:	5.25 kN/m ²			

Additional Comments If Required

Item: Loadings and Reactions on 750mm ApolloBeam Dead Load (kN/m) **0.28**

Max Span (m)	Main SWL (kN/m ²)
4.35	10
Beam C/C (m)	Inside SWL (kN/m ²)
1	0
No Inside Boards	Boards Sw (kN/m ²)
0	0.25

	UDL (kN/m)
Inside Beam:	5.41
	UDL (kN/m)
Centre Beam:	10.53
	UDL (kN/m)
Perimeter Beam:	5.41

Coupler CapacitiesCoupler Type Used - Class A: **Y** 6.1kNCoupler Type Used - Class B: **Y** 9.1kN

Node loads in accordance with TG20:21, 5.9.2

No. of Primary Connections: **2**No. of Supplementary Connections: **2**Strength of Connection: **30.40kN****Maximum Reactions Centre Beam**

Weight	*	Length	/	2	=	Reaction
10.53	*	4.35m	/	2	=	22.90 kN
10.53	*	4.35m	/	2	=	22.90 kN

Support

1	22.90kN	<	30.40 kN
2	22.90kN	<	30.40 kN

PASSES
PASSES**Maximum Shear Centre Beam**

Weight	*	Length	/	2	=	Shear
10.53	*	4.35m	/	2	=	22.90 kN
10.53	*	4.35m	/	2	=	22.90 kN

Support

1	22.90	<	45.50 kN
2	22.90	<	45.50 kN

PASSES
PASSES**Maximum BM Centre Beam**

Weight	*	Length ²	/	8	=	BM
10.53	*	4.35m	/	8	=	24.91 kNm
10.53	*	4.35m	/	8	=	24.91 kNm

Support

1	24.9kNm	<	42.90 kNm
2	24.9kNm	<	42.90 kNm

PASSES
PASSES

Loads Imposed on to Structure Leg Loads Centre Beam

Support	Reaction		Additional Leg/Loads		Additional Leg/Loads		Total Load
1	22.90kN	+	0.40kN	+		=	23.30kN
2	22.90kN	+	0.53kN	+		=	23.43kN

No. Support Stds/Puncheons **1**

Axial Load	Effective Length (LE)	Safe Axial Load (Pc)	Slenderness Ratio (λ)	Slenderness Max (λ)	Result
23.30kN	2.0 m	29.10kN	127.1	271	PASSES
23.43kN	2.0 m	29.10kN	127.1	271	PASSES

Ground Bearing Pressure (GBP)

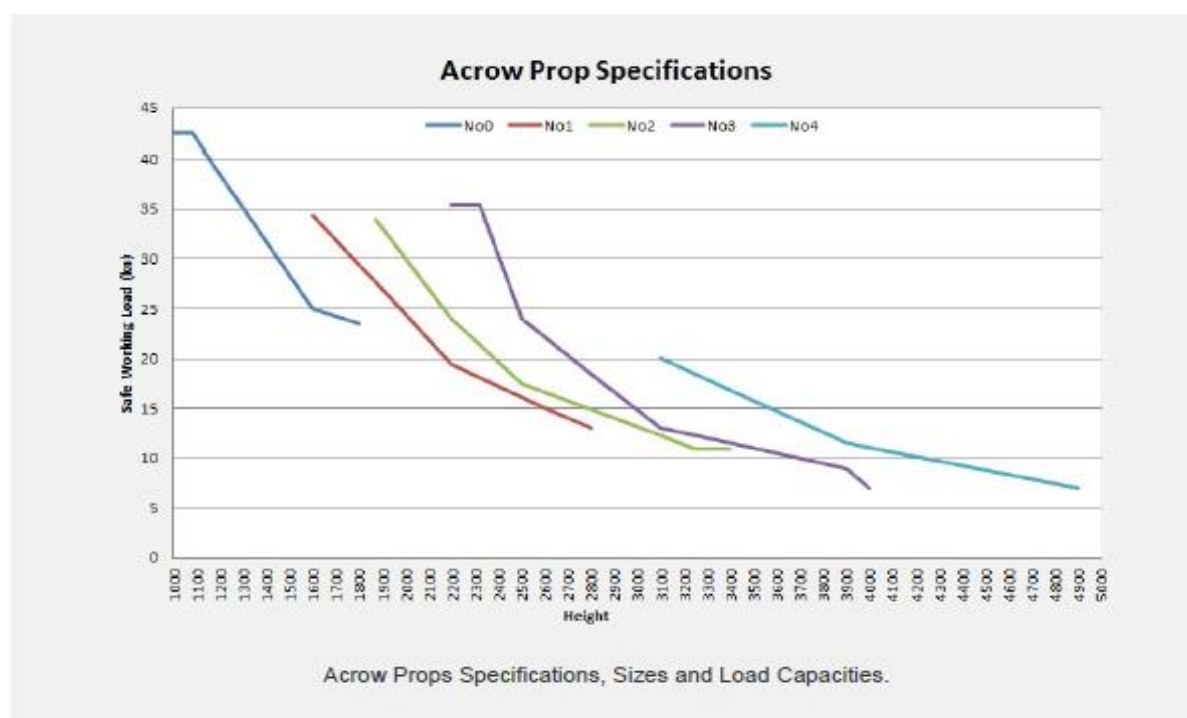
		Sole Pad Arrangements		
		Pad Width (m)	Pad Length (m)	Pad Area (sqm)
Typical Arrangement	y	0.225	0.450	0.10125
Increased Arrangement		0.450	0.450	0.2025
Tredda Plate		0.210	0.210	0.0441
Other				0

Imposed Load S1: **23.30 kN**

GBP: **230.14 kN/m²**

Imposed Load S2: **23.43 kN**

GBP: **231.45 kN/m²**

Consider Acro Prop Capacity (Type No. 4)**The No.4 Acrow Prop**

- Fully adjustable from 3100 mm up to 4900 mm.
- Acro Props have a Safe Working Load of 20 KN at 3100 mm through to 7 KN at it's maximum height of 4900 mm.
- Weight 30 kg

Max Imposed Load:	23.43kN	<	12.00kN	FAILS	
No. Props					
23.43kN / 2	=	11.72kN	<	12.00kN	PASSES

Total Area (m²)			
4.45m	*	0.95m	= 4.228
Area (m²)		Live Load	Result
4.228	*	10.00kN	= 42.28kN
			Result
42.28kN	*	10%	= 4.23kN

Max Imposed Load:

4.23kN

<

9.10kN

PASSES

Coupler Capacities

Coupler Type Used - Class A:

6.1kN

Coupler Type Used - Class B:

Y

9.1kN

Node loads in accordance with TG20:21, 5.9.2

No. of Primary Connections:

1

No. of Supplementary Connections:

0

Strength of Connection:

9.10kN

Project:	Rylands, Manchester
Drawing Number:	BDS - 10636 - 01 to 02
Item:	High Level Access Platform & Back Propping
Revision (if applicable):	A 24/11/2023
Category of Check (1, 2, or 3):	2

Description of Temporary Works:

High Level Access Platform & Back Propping

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:

10636 - 01	Plan A-A	Elevation B-B	Section C-C
10636 - 02	Plan D-D	Elevation E-E	Section F-F

Supporting Calculations: Page 1 to 15
Check Certificate: Page 16 of Calculations Document

Drawn By: Hayden Allan
Company: Buckley Design Solutions

Signature:



Drawing Status:
CONSTRUCTION

Calculations By: Brad Charles
Company: Buckley Design Solutions

Signature:



Checked By: Mike Brown
Company: Buckley Design Solutions

Signature:



Date:
24/11/2023