ALANWHITEDESIGN
INSPIRED ENGINEERING

Z0112-01-001B
APOLLO SCAFFOLD SERVICES
9' LADDER BEAM
STANDARD CAPACITY TABLES
DESIGN CHECK CALCULATIONS

ALAN N WHITE
B.Sc., M.Eng., C.Eng., M.I.C.E., M.I.H.T.

MALACHY RYAN
B.Eng, M.Sc., C.Eng., M.I.C.E.

OCT 2020

REGISTERED IN SCOTLAND:
Company No. SC349820
17-19 Hill Street, Kilmarnock, KA3 1HA

PHONE: 01563 594621
FAX: 01563 593056
enquiry@alanwhitedesign.com
www.alanwhitedesign.com

AWD016-03 Rev 3 By EMcG 26-01-2018

DOCUMENT REVISION HISTORY

REVISION	DESCRIPTION	AUTHOR	REVISION DATE	CHECKED
A	Initial Issue	MO	20/05/2019	MMR
B	Summary revised	EAS	29/10/2020	MMR

Client :	Apollo Scaffold Services			
Project :	9 Inch Ladder Beam			
Element :	Brief			
Job No :	Z0112-01	By: mo	Date: Oct 20	
Doc No :	001B	Checked: mmr	Date: Oct 20	

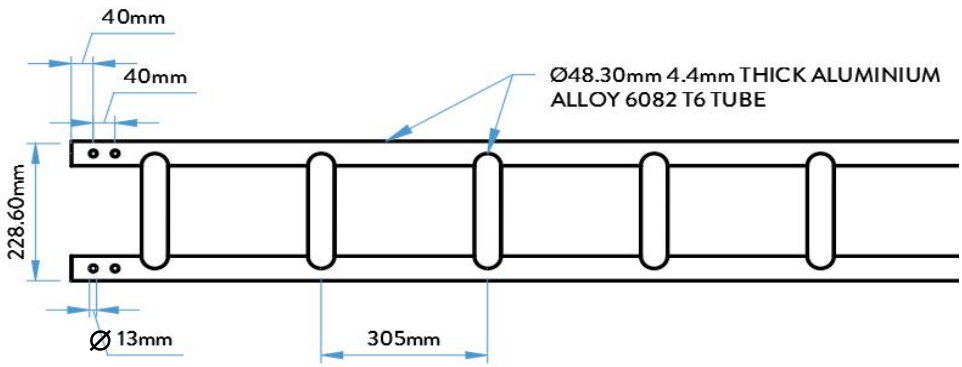
Brief

To prepare calculated values for the capacity of the Apollo Aluminium 9 Inch Ladder Beam in accordance to BS EN 1999-1-1.

The beams are manufactured from tube extrusions in aluminium alloy grade 6082 T6.

Layout

Ladder Beam Geometry as shown below:



Design

Eurocode 0: Basis of structural design	EN 1990
Eurocode 9: Design of Aluminium structures	EN 1999-1-1

Alloy

The alloy used is 6082 T6:

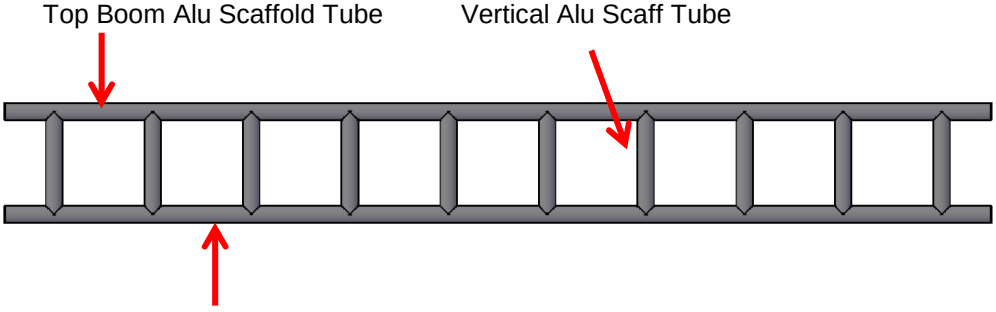
f_o= 255 N/mm^2

f_u= 295 N/mm^2

STRAP Model

The structure was analysed in STRAP structural analysis program.
(3m Ladder Beam shown below, larger spans are scaled versions of below)

Top Boom Alu Scaffold Tube Vertical Alu Scaff Tube

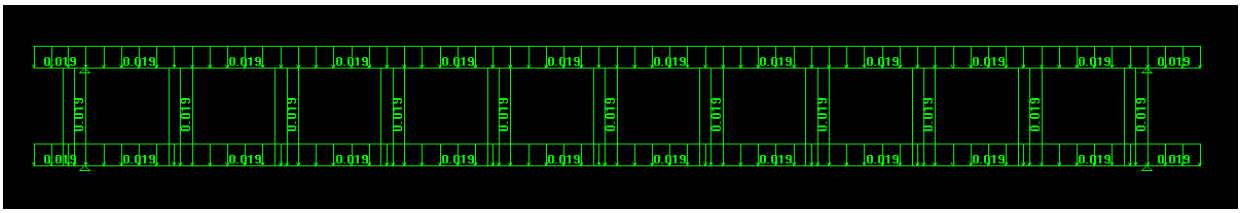


Bottom Boom Alu Scaffold Tube

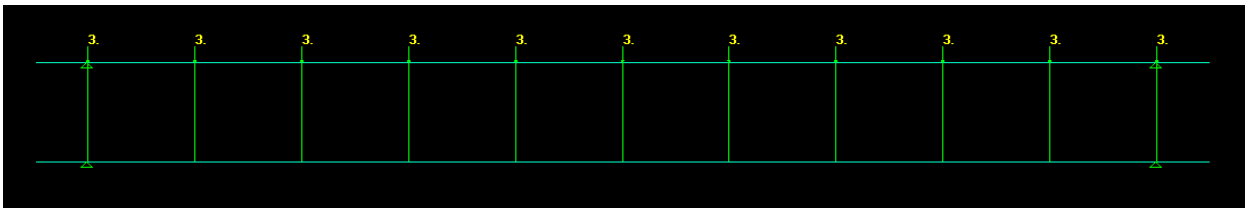
Load Cases

Images are shown of the 3m beam, loading for larger spans is applied using the same methodology.

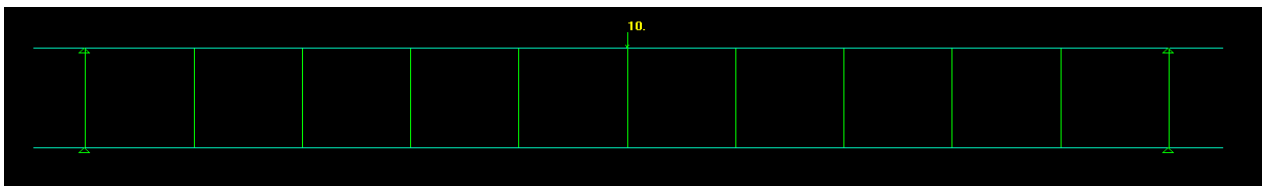
Load Case 1 **Self Weight**
Self weight of all booms and verticals factored by 1.15 to account for all connections



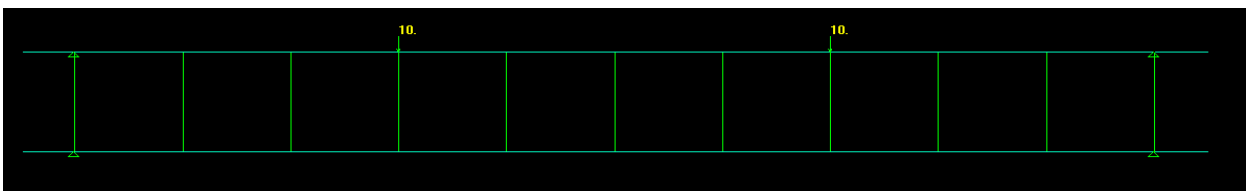
Load Case 2 **UDL**
10kN/m Load Applied to top boom over full length of the Ladder Beam at node points



Load Case 3 **Central Point Load**
10kN Point Load Applied to Centre of Top Boom of the Ladder Beam

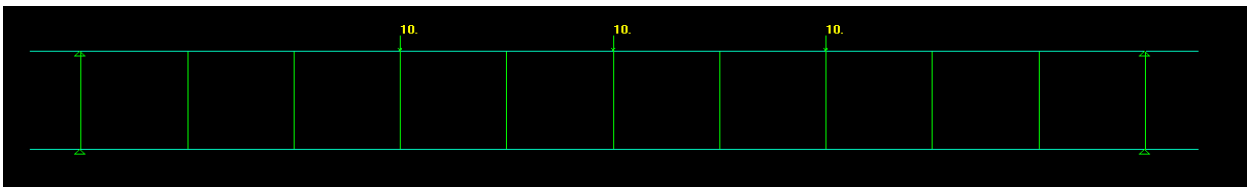


Load Case 4 **Two Point Loads**
2No 10kN point loads applied at third points along the top boom of the Ladder Beam.



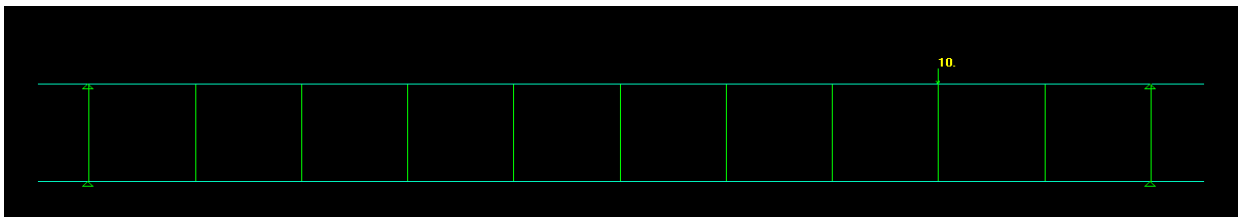
Load Case 5 **Three Point Loads**

3No 10kN Point Loads applied at quarter points along the Ladder Beam



Load Case 6 **End Shear**

10kN Point Load applied 0.6m from support



Load Combinations

Combination Number	Combination Description	Load Cases
1	UDL	1+2
2	Central Point Load	1+3
3	Two Point Loads	1+4
4	Three Point Loads	1+5
5	End Shear	1+6

Above Combinations were checked for the following design factors:

γ_D= 1.35

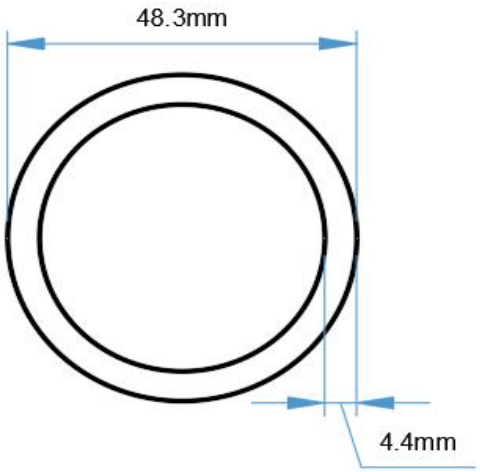
γ_L= 1.50

Main Boom - Ø48.30mm, 4.40mm Thick CHS

Alu. 6082-T6

$P_{o,haz}$ =	0.50	
$P_{u,haz}$ =	0.64	
F_o =	250	N/mm^2
F_u =	290	N/mm^2

Class A Material



A =	606.80	mm^2
L =	1000	mm
k =	0.70	
L_{cr} =	700	mm
I =	147655	mm^4
y =	24.20	mm
W_{el} =	6101	mm^3
W_{pl} =	8237	mm^3
r_y =	17.7	mm

For slenderness

β =	b/t	b=	48.30	mm
=	10.98	t =	4.40	mm
ε =	sqrt(250/f_o)	f_o=	250	N/mm^2
=	1.00			

Class A, without welds, Internal parts

β_1 =	11ε	
=	11*1.00	
=	11.00	Table 6.2
>	10.98	

Section is class 1

$P_{o,haz}$ / $P_{u,haz}$ Factors

All welds are assumed to be tungsten inert gas welds (TIG).

As per EN 1999-1-1 6.1.6.3

b_{haz} = 30mm 6.1.6.3

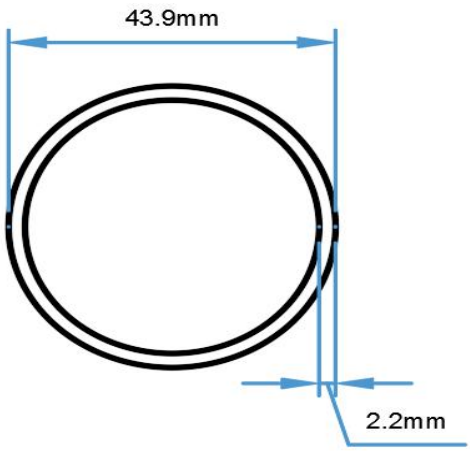
Two partial welds at either end of boom section overalp, therefore assume entire boom section is affected by HAZ.

As per BS EN 1999-1-1, for HAZ wall thickness factored by 0.50 (For $P_{o,haz}$)

As per BS EN 1999-1-1, for HAZ wall thickness factored by 0.64 (For $P_{u,haz}$)

$P_{o,haz}$ HAZ Section Layout

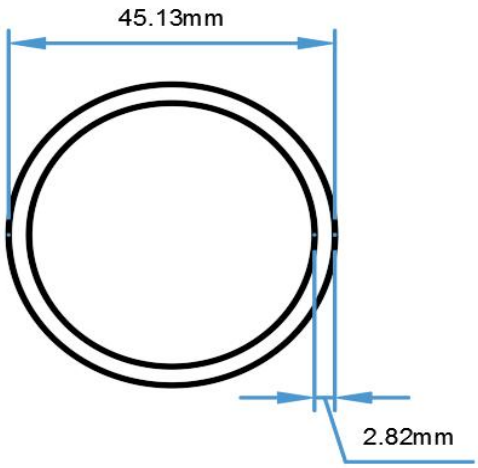
As per BS EN 1999-1-1, for HAZ wall thickness factored by 0.50



A_{haz}=	288	mm^2
I=	62820	mm^4
I_z=	62820	mm^4
W_{el}=	2,862	mm^3
W_{pl}=	3,864	mm^3

$P_{u,haz}$ HAZ Section Layout

As per BS EN 1999-1-1, for HAZ wall thickness factored by 0.64



A_{haz}=	374	mm^2
I=	84308	mm^4
I_z=	84308	mm^4
W_{el}=	3,735	mm^3
W_{pl}=	5,043	mm^3

Main Boom Moment Capacity

Non-HAZ (6.2.5.1)

$M_{c,Rd} = \alpha W_{el} f_o / \gamma_{M1}$

α =	W_{pl}/W_{el}	(Table 6.4)
=	1.35	
W_{el} =	6.10	cm^3
f_o =	250	N/mm^2
γ_{M1} =	1.1	(6.1.3)

= 1.35*6.10*250/1100

$M_{c,Rd}$ = 1.87 kNm

HAZ

$M_{u,Rd} = W_{net} f_u / \gamma_{M2}$

W_{net} =	$W_{u\ eff}$	
=	2.86	cm^3
f_u =	290	N/mm^2
γ_{M2} =	1.25	(6.1.3)

= 2.86*290/1250

$M_{u,Rd}$ = 0.66 kNm

$M_{Rd,x}$ = 0.66 kNm lesser value of $M_{c,Rd}$ / $M_{u,Rd}$

Main Boom Shear Capacity

(6.2.6)

$V_{Rd} = A_v f_o / \sqrt{3}\gamma_{M1}$

$A_v = nA_e$

$n = 0.6$

$A_e = 288$ mm^2

$A_v = 0.6*288$

$A_v = 172.80$ mm^2

$f_o = 250$ N/mm^2

$\gamma_{M1} = 1.1$

$= 172.80*250/(SQRT(3)*1100)$

$V_{Rd} = 22.67$ kN

Axial Comp Capacity

Without Weld

$N_{b,Rd} = kX A_{eff} f_o / \gamma_{M1}$ (6.3.1.1 (6.49a))

$N_{cr} = \pi^2 EI / L_{cr}^2$ (Appendix I.3)

$E = 70{,}000$ N/mm^2

$I = 147{,}655$ mm^4

$L_{cr} = 700.00$ mm

$N_{cr} = (((PI()^2)*70000*147655))/((700^2))$

$= 208{,}185.21$ N

$\lambda = \sqrt{A_{eff} f_o / N_{cr}}$ (6.3.1.2)

$= 0.85$ $A_{eff} = 607$ mm^2

$X = 1/ \Phi+\sqrt{\Phi^2-\lambda^2}$

$\Phi = 0.5(1+\acute{\alpha}(\lambda-\lambda_o)+\lambda^2)$

$\acute{\alpha} = 0.20$ Table 6.6

$\lambda_o = 0.10$ Table 6.6

$\Phi = 0.94$

$X = 0.75$

$k = 1.00$ (no welds)

$N_{b,Rd} = 1.00*0.75*607*250/1100$

$= 103.47$ kN

Localised Weld

$N_{b,Rd} = X_{haz}\omega_{x,haz} A_{u,eff} f_u / \gamma_{M2}$ (6.3.1.1 (6.49b))

$N_{cr} = \pi^2 EI / L_{cr}^2$ (Appendix I.3)

$E =$ 70,000 N/mm^2

$I =$ 62,820 mm^4

$L_{cr} =$ 700.00 mm

$N_{cr} =$ (((PI()^2)*70000*62820))/((700^2))

$=$ 88,572.65 N

$\lambda_{haz} = \sqrt{A_{u,eff} f_u / N_{cr}}$ (6.3.1.2)

$= 0.91$

$A_{u,eff} =$ 288 mm^2

$X_{haz} = 1/ \Phi+\sqrt{\Phi^2-\lambda^2}$

$\Phi = 0.5(1+\acute{\alpha}(\lambda-\lambda_o)+\lambda^2)$

$\acute{\alpha} =$ 0.20 Table 6.6

$\lambda_o =$ 0.10 Table 6.6

$\Phi =$ 1.00

$X_{haz} =$ 0.71

$\omega_{x,haz} = 1/X_{haz}+(1-X_{haz})\sin(PI()x_{s,haz}/lcr)$

$x_{s,haz} = (L-L_{cr})/2$

$= (1000-700)/2$

$=$ 150.00 mm

$=$ 1.12

$N_{b,Rd} =$ 1.00*0.71*288*290/1250

$=$ 47.44 kN

Lesser Value= 47.44 kN

Axial Tension Capacity

(6.2.3)

1. General yielding

$N_{o,Rd} = A_g f_o / \gamma_{M1}$

$f_o =$ 250 N/mm^2

$A_g =$ A

$=$ 607 mm^2

$\gamma_{M1} =$ 1.1

$=$ 607*250/1100

$=$ 137.95 kN

2. Local failure

$N_{u,Rd} = A_{u,eff} f_u / \gamma_{M2}$

$f_u =$ 290 N/mm^2

$A_{u,eff} =$ 288 mm^2

$\gamma_{M1} =$ 1.25

$=$ 288*290/1250

$=$ 66.82 kN

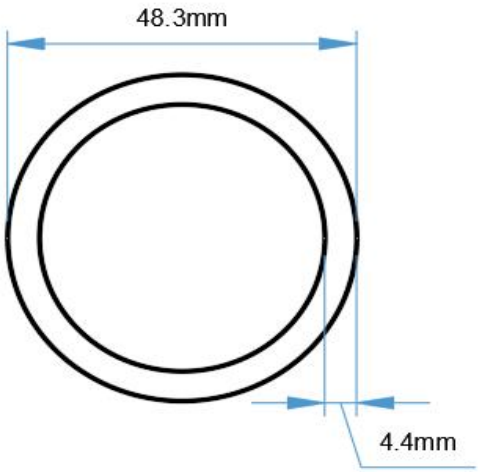
Lesser Value= 66.82 kN

Vertical Tube - Ø48.30mm, 4.40mm Thick CHS

Alu. 6082-T6

$P_{o,haz}$ =	0.50	
$P_{u,haz}$ =	0.64	
F_o =	250	N/mm^2
F_u =	290	N/mm^2

Class A Material



A =	606.80	mm^2
L =	228	mm
k =	0.85	
L_{cr} =	193.8	mm
I =	147655	mm^4
y =	24.20	mm
W_{el} =	6101	mm^3
W_{pl} =	8237	mm^3
r_y =	17.7	mm

For slenderness

β =	b/t	b=	48.30	mm
=	10.98	t =	4.40	mm
ε =	sqrt(250/f_o)	f_o=	250	N/mm^2
=	1.00			

Class A, without welds, Internal parts

β_1 =	11ε	
=	11*1.00	
=	11.00	Table 6.2
>	10.98	

Section is class 1

$P_{o,haz}$ / $P_{u,haz}$ Factors

All welds are assumed to be tungsten inert gas welds (TIG).

As per EN 1999-1-1 6.1.6.3

b_{haz} = 30mm 6.1.6.3

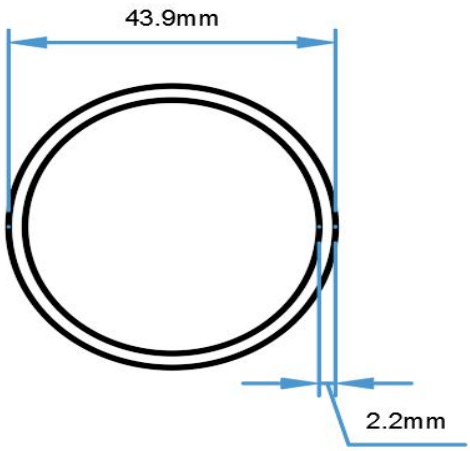
Two partial welds at either end of boom section overalp, therefore assume entire boom section is affected by HAZ.

As per BS EN 1999-1-1, for HAZ wall thickness factored by 0.50 (For $P_{o,haz}$)

As per BS EN 1999-1-1, for HAZ wall thickness factored by 0.64 (For $P_{u,haz}$)

$P_{o,haz}$ HAZ Section Layout

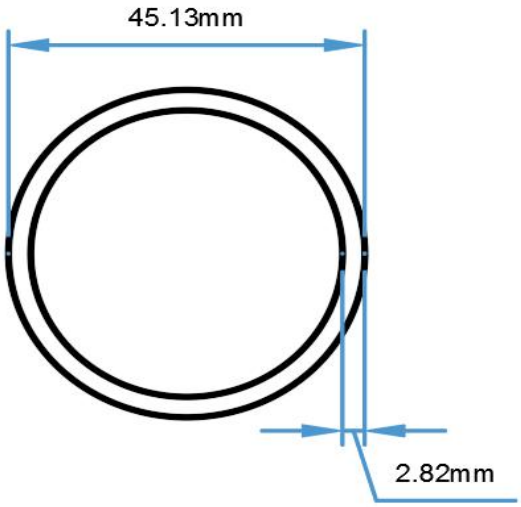
As per BS EN 1999-1-1, for HAZ wall thickness factored by 0.50



A_{haz}=	288	mm^2
I=	62820	mm^4
I_z=	62820	mm^4
W_{el}=	2,862	mm^3
W_{pl}=	3,864	mm^3

$P_{u,haz}$ HAZ Section Layout

As per BS EN 1999-1-1, for HAZ wall thickness factored by 0.64



A_{haz}=	374	mm^2
I=	84308	mm^4
I_z=	84308	mm^4
W_{el}=	3,735	mm^3
W_{pl}=	5,043	mm^3

Main Boom Moment Capacity

Non-HAZ (6.2.5.1)

$M_{c,Rd} = \alpha W_{el} f_o / \gamma_{M1}$

α =	W_{pl}/W_{el}	(Table 6.4)
=	1.35	
W_{el} =	6.10	cm^3
f_o =	250	N/mm^2
γ_{M1} =	1.1	(6.1.3)

= 1.35*6.10*250/1100

$M_{c,Rd}$ = 1.87 kNm

HAZ

$M_{u,Rd} = W_{net} f_u / \gamma_{M2}$

W_{net} =	$W_{u\ eff}$	
=	62.82	cm^3
f_u =	290	N/mm^2
γ_{M2} =	1.25	(6.1.3)

= 2.86*290/1250

$M_{u,Rd}$ = 0.66 kNm

$M_{Rd,x}$ = 0.66 kNm lesser value of $M_{c,Rd}$ / $M_{u,Rd}$

Main Boom Shear Capacity

(6.2.6)

$V_{Rd} = A_v f_o / \sqrt{3}\gamma_{M1}$

$A_v =$	nA_e	
$n =$	0.6	
$A_e =$	288	mm^2
$A_v =$	0.6*288	
$A_v =$	172.80	mm^2
$f_o =$	250	N/mm^2
$\gamma_{M1} =$	1.1	

= 172.80*250/(SQRT(3)*1100)

$V_{Rd} =$ 22.67 kN

Axial Comp Capacity

Without Weld

$N_{b,Rd} = kX A_{eff} f_o / \gamma_{M1}$ (6.3.1.1 (6.49a))

$N_{cr} = \pi^2 EI / L_{cr}^2$ (Appendix I.3)

$E =$	70,000	N/mm^2
$I =$	147,655	mm^4
$L_{cr} =$	193.80	mm

N_{cr} = (((PI()^2)*70000*147655))/((193.80^2))

= 2,716,053.99 N

$\lambda = \sqrt{A_{eff}} f_o / N_{cr}$ (6.3.1.2)

= 0.24 $A_{eff} =$ 607 mm^2

$X = 1/ \Phi+\sqrt{\Phi^2-\lambda^2}$

$\Phi = 0.5(1+\acute{\alpha}(\lambda-\lambda_o)+\lambda^2)$

$\acute{\alpha} =$	0.20	Table 6.6
$\lambda_o =$	0.10	Table 6.6
$\Phi =$	0.54	

X = 0.97

k= 1.00 (no welds)

$N_{b,Rd}$ = 1.00*0.97*607*250/1100

= 133.82 kN

Localised Weld

$N_{b,Rd} = X_{haz}\omega_{x,haz} A_{u,eff} f_u / \gamma_{M2}$ (6.3.1.1 (6.49b))

$N_{cr} = \pi^2 EI / L_{cr}^2$ (Appendix I.3)

$E =$ 70,000 N/mm^2

$I =$ 288 mm^4

$L_{cr} =$ 193.80 mm

$N_{cr} =$ (((PI()^2)*70000*62820))/((193.80^2))

$=$ 1,155,548.48 N

$\lambda_{haz} = \sqrt{A_{u,eff} f_u / N_{cr}}$ (6.3.1.2)

$=$ 0.25

$A_{u,eff} =$ 288 mm^2

$X_{haz} = 1/ \Phi+\sqrt{\Phi^2-\lambda^2}$

$\Phi = 0.5(1+\acute{\alpha}(\lambda-\lambda_o)+\lambda^2)$

$\acute{\alpha} =$ 0.20 Table 6.6

$\lambda_o =$ 0.10 Table 6.6

$\Phi =$ 0.55

$X_{haz} =$ 0.97

$\omega_{x,haz} = 1/X_{haz}+(1-X_{haz})\sin(PI()x_{s,haz}/lcr)$

$x_{s,haz} = (L-L_{cr})/2$

$= (228-193.80)/2$

$=$ 17.10 mm

$=$ 1.02

$N_{b,Rd} =$ 1.00*0.97*288*290/1250

$=$ 66.15 kN

Lesser Value= 66.15 kN

Axial Tension Capacity

(6.2.3)

1. General yielding

$N_{o,Rd} = A_g f_o / \gamma_{M1}$

$f_o =$ 250 N/mm^2

$A_g =$ A

$=$ 607 mm^2

$\gamma_{M1} =$ 1.1

$=$ 607*250/1100

$=$ 137.95 kN

2. Local failure

$N_{u,Rd} = A_{u,eff} f_u / \gamma_{M2}$

$f_u =$ 290 N/mm^2

$A_{u,eff} =$ 288 mm^2

$\gamma_{M1} =$ 1.25

$=$ 288*290/1250

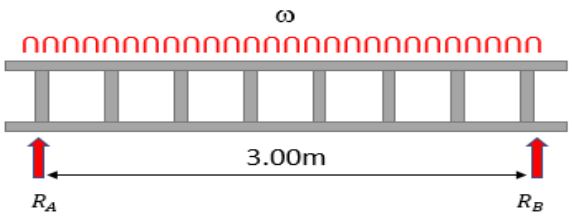
$=$ 66.82 kN

Lesser Value= 66.82 kN

3.00m Ladder Beam Results

Load Comb.1 **UDL load** **(10kN/m applied along beam)**

Element	Action	Formula	Capacity	Calculated	Factor
Boom	Moment	$M_{c,Rd}$	0.66	1.20	0.55
	Shear	V_{Rd}	22.67	6.90	3.29
	Tension	$N_{o,Rd}$	66.82	29.07	2.30
	Compression	$N_{b,Rd}$	47.44	29.07	1.63
	Deflection	d	30	12.37	2.43
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.45
Vertical	Moment	$M_{c,Rd}$	0.66	1.70	0.39
	Shear	V_{Rd}	22.67	18.84	1.20
	Tension	$N_{o,Rd}$	66.82	0.01	6681.60
	Compression	$N_{b,Rd}$	66.15	1.53	43.23
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.39
				Factor	**0.39**



(Note : Beam sketches do not reflect the real number of vertical tubes in beam)

Max Moment Formula = $ML^2/8$

Ultimate condition (W) = 1.5*10
= 15.00 kN

Apply Above Calculated Factor (Wf) = 15*0.39
= 5.85 kN

Maximum UltimateMoment (M_U)= $Wf*L^2/8$
= (5.85*3^2)/8
= 6.58 kNm

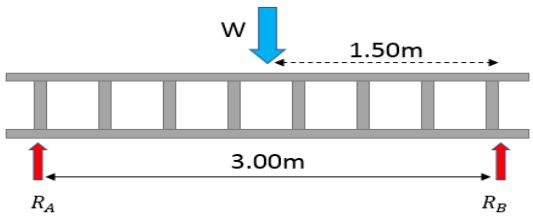
Maximum Allowable Moment (M_A)= 6.58/1.50
= 4.39 kNm

Moment values	**Ultimate**	**6.58 kNm**
	Allowable	**4.39 kNm**

Client :	Apollo Scaffold Services			
Project :	9 Inch Ladder Beam			
Element :	3.00m Ladder Beam Results			
Job No :	Z0112-01	By: mo	Date: Oct 20	
Doc No :	001B	Checked: mmr	Date: Oct 20	

Load Comb. 2 **Point load** **(10kN load applied at midspan of beam)**

Element	Action	Formula	Capacity	Calculated	Factor
Boom	Moment	$M_{c,Rd}$	0.66	0.52	1.28
	Shear	V_{Rd}	22.67	2.54	8.93
	Tension	$N_{o,Rd}$	66.82	16.04	4.17
	Compression	$N_{b,Rd}$	47.44	16.04	2.96
	Deflection	d	30.00	8.07	3.72
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.98
Vertical	Max Moment	$M_{c,Rd}$	0.66	0.74	0.90
	Shear	V_{Rd}	22.67	8.24	2.75
	Tension	$N_{o,Rd}$	66.82	0.01	6681.60
	Compression	$N_{b,Rd}$	66.15	0.01	6614.78
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.90
	Max Comp	$N_{b,Rd}$	66.15	4.94	13.39
	Moment	$M_{c,Rd}$	0.66	0.01	66.35
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	12.01
				Factor	**0.90**



Max Moment Formula = ML/4

so for ultimate conccondition (W) = 1.50*10
= 15.00 kN

Apply Above Calculated Factor (Wf) = 15*0.90
= 13.50 kN

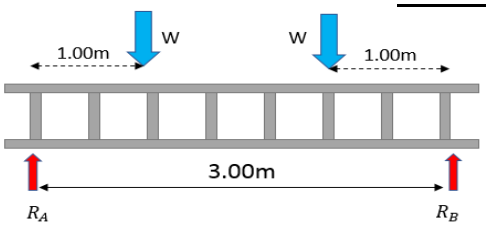
Maximum UltimateMoment (M_U)= Wf*L/4
= 13.50*3/4
= 10.13 kNm

Maximum Allowable Moment (M_A)= 10.13/1.50
= 6.75 kNm

Moment values	**Ultimate**	**10.13 kNm**
	Allowable	**6.75 kNm**

Load Comb. 3 **PL at 1/3 points** **(10kN load applied at each of the two third points)**

Element	Action	Formula	Capacity	Calculated	Factor
Boom	Max Moment	$M_{c,Rd}$	0.66	0.91	0.73
	Shear	V_{Rd}	22.67	5.05	4.49
	Tension	$N_{o,Rd}$	66.82	25.37	2.63
	Compression	$N_{b,Rd}$	47.44	0.01	4743.94
	Deflection	d	30.00	10.29	2.92
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.73
	Max Comp	$N_{b,Rd}$	47.44	25.37	1.87
	Moment	$M_{c,Rd}$	0.66	0.91	0.73
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.56
Vertical	Max Moment	$M_{c,Rd}$	0.66	1.42	0.47
	Shear	V_{Rd}	22.67	15.72	1.44
	Tension	$N_{o,Rd}$	66.82	0.01	6681.60
	Compression	$N_{b,Rd}$	66.15	0.01	6614.78
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.47
	Max Comp	$N_{b,Rd}$	66.15	4.94	13.39
	Moment	$M_{c,Rd}$	0.66	0.75	0.88
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.84
				Factor	**0.39**



Max Moment Formula = ML/3

Ultimate condition (W) = 1.50*10
= 15.00 kN

Apply Above Calculated Factor (Wf) = 15*0.39
= 5.85 kN

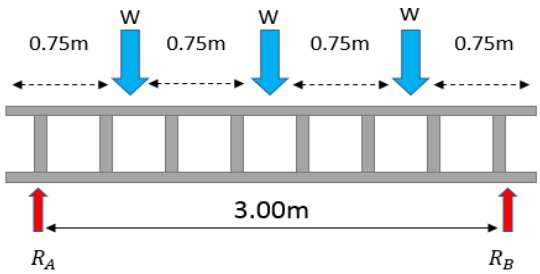
Maximum UltimateMoment (M_U)= Wf*L/3
= (5.85*3)/3
= 5.85 kNm

Maximum Allowable Moment (M_A)= 5.85/1.50
= 3.90 kNm

Moment values	**Ultimate**	**5.85 kNm**
	Allowable	**3.90 kNm**

Load Comb. 4 **PL at 1/4 points** **(10kN load applied at each of the three quarter points)**

Element	Action	Formula	Capacity	Calculated	Factor
Boom	Moment	$M_{c,Rd}$	0.66	1.37	0.48
	Shear	V_{Rd}	22.67	7.55	3.00
	Tension	$N_{o,Rd}$	66.82	41.27	1.62
	Compression	$N_{b,Rd}$	47.44	41.27	1.15
	Deflection	d	30.00	18.29	1.64
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.37
Vertical	Max Moment	$M_{c,Rd}$	0.66	2.14	0.31
	Shear	V_{Rd}	22.67	23.69	0.96
	Tension	$N_{o,Rd}$	66.82	0.01	6681.60
	Compression	$N_{b,Rd}$	66.15	0.04	1653.70
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.31
	Max Comp	$N_{b,Rd}$	66.15	4.93	13.42
	Moment	$M_{c,Rd}$	0.66	1.48	0.45
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.44
				Factor	**0.31**



Max Moment Formula = ML/2

Ultimate condition (W) = 1.50*10
= 15.00 kN

Apply Above Calculated Factor (Wf) = 15*0.31
= 4.65 kN

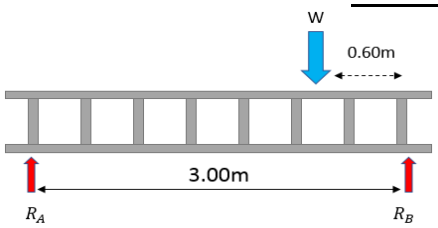
Maximum UltimateMoment (M_U)= Wf*L/2
= (4.65*3/2)
= 6.98 kNm

Maximum Allowable Moment (M_A)= 6.98/1.5
= 4.65 kNm

Moment values	**Ultimate**	**6.98 kNm**
	Allowable	**4.65 kNm**

Load Comb. 5 **End Shear** **(10kN load applied at a 0.6m distance from the support)**

Element	Action	Formula	Capacity	Calculated	Factor
Boom	Max Moment	$M_{c,Rd}$	0.66	0.75	0.88
	Shear	V_{Rd}	22.67	4.32	5.25
	Tension	$N_{o,Rd}$	66.82	0.01	6681.60
	Compression	$N_{b,Rd}$	47.44	2.68	17.70
	Deflection	d	30.00	4.36	6.88
	Combined Axial	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.87
	Max Comp	$N_{b,Rd}$	47.44	9.89	4.80
	Moment	$M_{c,Rd}$	0.66	0.74	0.90
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.79
Vertical	Max Moment	$M_{c,Rd}$	0.66	1.12	0.59
	Shear	V_{Rd}	22.67	9.78	2.32
	Tension	$N_{o,Rd}$	66.82	0.01	6681.60
	Compression	$N_{b,Rd}$	66.15	0.05	1322.96
	Combined Axial	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.59
	Max Comp	$N_{b,Rd}$	66.15	4.93	13.42
	Moment	$M_{c,Rd}$	0.66	0.52	1.28
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	1.19
				Factor	**0.51**



Max Shear Formula = W*2.4/3

Ultimate condition (W) = 1.50*10
= 15.00 kN

Apply Above Calculated Factor (Wf) = 15*0.51
= 7.65 kN

Maximum Ultimate Shear (V_U)= Wf*2.4/3
= (7.65*2.4)/3
= 6.12 kN

Maximum Allowable Shear (V_A)= 6.12/1.50
= 4.08 kN

Shear values	**Ultimate**	**6.12 kN**
	Allowable	**4.08 kN**

3.00m Ladder Beam Analysis with restraints to compression chord at 1.00m c/c

Ladder Beam			
Loadcase No.		**Ultimate Moment**	**Allowable Moment**
1	UDL	6.58	4.39
2	Point	10.13	6.75
3	Third	5.85	3.90
4	Quarter	6.98	4.65

Loadcase No.		**Ultimate Shear**	**Allowable Shear**
5	End Shear	6.12	4.08

Max Allowable Moment = 3.90 kNm

Max Allowable Shear = 4.00 kN

From 3.00m Ladder Beam Analysis with restraints to compression chord at 1.00m c/c

For simply supported Apollo single Ladder Beam TO EUROCODE EN 1999-1

Allowable Bending Moment	3.90 kNm
Allowable Shear	4.00 kN

Allowable loads for load distributions

Type of Load		Clear span (m)										
		2	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Uniformly Distributed load	**kN/m**	7.80	3.47	1.95	1.25	0.87	0.64	0.49	0.39	0.31	0.26	0.22
Total UDL	**kN**	15.60	10.40	7.80	6.24	5.20	4.46	3.90	3.47	3.12	2.84	2.60
Single point load (mid Point)	**kN**	7.80	5.20	3.90	3.12	2.60	2.23	1.95	1.73	1.56	1.42	1.30
Two point loads (third points)	**Each kN**	5.85	3.90	2.93	2.34	1.95	1.67	1.46	1.30	1.17	1.06	0.98
Three pint loads (quarter points)	**Each kN**	3.90	2.60	1.95	1.56	1.30	1.11	0.98	0.87	0.78	0.71	0.65
		2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00	11.00	12.00
Uniformly Distributed load	**kN/m**	4.00	2.67	2.00	1.60	1.33	1.14	1.00	0.89	0.80	0.73	0.67
Total UDL	**kN**	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
Single point load (mid Point)	**kN**	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
Two point loads (third points)	**Each kN**	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Three pint loads (quarter points)	**Each kN**	2.67	2.67	2.67	2.67	2.67	2.67	2.67	2.67	2.67	2.67	2.67
Type of Load		Clear span (m)										
		2	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Uniformly Distributed load	**kN/m**	4.00	2.67	1.95	1.25	0.87	0.64	0.49	0.39	0.31	0.26	0.22
Total UDL	**kN**	8.00	8.00	7.80	6.24	5.20	4.46	3.90	3.47	3.12	2.84	2.60
Single point load (mid Point)	**kN**	7.80	5.20	3.90	3.12	2.60	2.23	1.95	1.73	1.56	1.42	1.30
Two point loads (third points)	**Each kN**	4.00	3.90	2.93	2.34	1.95	1.67	1.46	1.30	1.17	1.06	0.98
Three point loads (quarter points)	**Each kN**	2.67	2.60	1.95	1.56	1.30	1.11	0.98	0.87	0.78	0.71	0.65

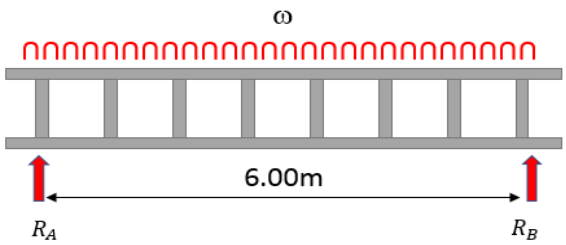
Notes:

1. Above allowable loads may be increased by 1.11 for **wind loading only**
2. This table is provided as a guide only and assume all loads are applied at nodes. All scaffolds and structures should be checked by a qualified structural engineer. Loads indicated in italics and shaded are limited by shear.
3. Maximum capacity of a point load mid way between nodes is 7.80kN but overall buckling of the top chord should be checked if loads are placed other than at restrained loads. Compression chord restraint required at 1m c/c
4. Restraint point must support both top and bottom booms at restraint location.

6.00m Ladder Beam Results

Load Comb.1 **UDL load** **(10kN/m applied along beam)**

Element	Action	Formula	Capacity	Calculated	Factor
Boom	Moment	$M_{c,Rd}$	0.66	2.73	0.24
	Shear	V_{Rd}	22.67	14.57	1.56
	Tension	$N_{o,Rd}$	66.82	141.32	0.47
	Compression	$N_{b,Rd}$	47.44	141.32	0.34
	Deflection	d	60	85.71	0.70
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.16
Vertical	Moment	$M_{c,Rd}$	0.66	3.89	0.17
	Shear	V_{Rd}	22.67	43.15	0.53
	Tension	$N_{o,Rd}$	66.82	0.01	6681.60
	Compression	$N_{b,Rd}$	66.15	1.53	43.23
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.17
				Factor	**0.16**



(Note : Beam sketches do not reflect the real number of vertical tubes in beam)

Max Moment Formula = $ML^2/8$

Ultimate condition (W) = 1.5*10
= 15.00 kN

Apply Above Calculated Factor (Wf) = 15*0.16
= 2.40 kN

Maximum UltimateMoment (M_U)= $Wf*L^2/8$
= (2.40*6^2)/8
= 10.80 kNm

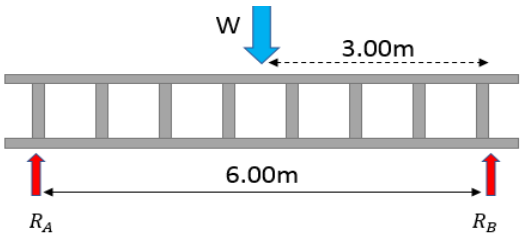
Maximum Allowable Moment (M_A)= 10.80/1.50
= 7.20 kNm

Moment values	**Ultimate**	**10.80 kNm**
	Allowable	**7.20 kNm**

Client :	Apollo Scaffold Services			
Project :	9 Inch Ladder Beam			
Element :	6.00m Ladder Beam Results			
Job No :	Z0112-01	By: mo	Date: Oct 20	
Doc No :	001B	Checked: mmr	Date: Oct 20	

Load Comb. 2 **Point load** **(10kN load applied at midspan of beam)**

Element	Action	Formula	Capacity	Calculated	Factor
Boom	Moment	$M_{c,Rd}$	0.66	0.58	1.14
	Shear	V_{Rd}	22.67	2.57	8.82
	Tension	$N_{o,Rd}$	66.82	22.37	2.99
	Compression	$N_{b,Rd}$	47.44	37.25	1.27
	Deflection	d	60.00	28.06	2.14
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.66
Vertical	Max Moment	$M_{c,Rd}$	0.66	0.76	0.87
	Shear	V_{Rd}	22.67	8.38	2.71
	Tension	$N_{o,Rd}$	66.82	0.01	6681.60
	Compression	$N_{b,Rd}$	66.15	0.01	6614.78
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.87
	Max Comp	$N_{b,Rd}$	66.15	4.91	13.47
	Moment	$M_{c,Rd}$	0.66	0.01	66.35
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	12.04
				Factor	**0.66**



Max Moment Formula = ML/4

Ultimate condition (W) = 1.50*10
= 15.00 kN

Apply Above Calculated Factor (Wf) = 15*0.66
= 9.90 kN

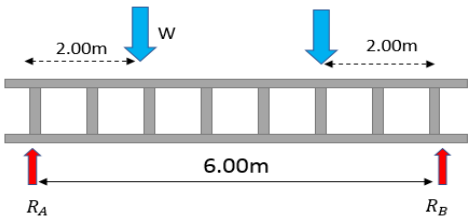
Maximum UltimateMoment (M_U)= Wf*L/4
= 9.90*6/4
= 14.85 kNm

Maximum Allowable Moment (M_A)= 14.85/1.50
= 9.90 kNm

Moment values	**Ultimate**	**14.85 kNm**
	Allowable	**9.90 kNm**

Load Comb. 3 **PL at 1/3 points** **(10kN load applied at each of the two third points)**

Element	Action	Formula	Capacity	Calculated	Factor
Boom	Max Moment	$M_{c,Rd}$	0.66	1.00	0.66
	Shear	V_{Rd}	22.67	5.07	4.47
	Tension	$N_{o,Rd}$	66.82	0.01	6681.60
	Compression	$N_{b,Rd}$	47.44	60.63	0.78
	Deflection	d	60.00	35.49	1.69
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.39
	Max Comp	$N_{b,Rd}$	47.44	60.63	0.78
	Moment	$M_{c,Rd}$	0.66	1.00	0.66
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.39
Vertical	Max Moment	$M_{c,Rd}$	0.66	1.49	0.45
	Shear	V_{Rd}	22.67	16.58	1.37
	Tension	$N_{o,Rd}$	66.82	0.01	6681.60
	Compression	$N_{b,Rd}$	66.15	0.01	6614.78
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.45
	Max Comp	$N_{b,Rd}$	66.15	4.94	13.39
	Moment	$M_{c,Rd}$	0.66	0.75	0.88
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.84
				Factor	**0.39**



Max Moment Formula = ML/3

Ultimate condition (W) = 1.50*10
= 15.00 kN

Apply Above Calculated Factor (Wf) = 15*0.39
= 5.85 kN

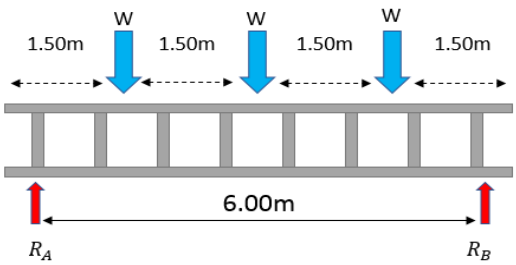
Maximum UltimateMoment (M_U)= Wf*L/3
= (5.85*6)/3
= 11.70 kNm

Maximum Allowable Moment (M_A)= 11.70/1.50
= 7.80 kNm

Moment values	**Ultimate**	**11.70 kNm**
	Allowable	**7.80 kNm**

Load Comb. 4 **PL at 1/4 points** **(10kN load applied at each of the three quarter points)**

Element	Action	Formula	Capacity	Calculated	Factor
Boom	Moment	$M_{c,Rd}$	0.66	1.49	0.45
	Shear	V_{Rd}	22.67	7.57	3.00
	Tension	$N_{o,Rd}$	66.82	89.78	0.74
	Compression	$N_{b,Rd}$	47.44	89.78	0.53
	Deflection	d	60.00	56.08	1.07
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.27
Vertical	Max Moment	$M_{c,Rd}$	0.66	2.23	0.30
	Shear	V_{Rd}	22.67	24.72	0.92
	Tension	$N_{o,Rd}$	66.82	0.01	6681.60
	Compression	$N_{b,Rd}$	66.15	0.01	6614.78
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.30
	Max Comp	$N_{b,Rd}$	66.15	4.94	13.39
	Moment	$M_{c,Rd}$	0.66	0.01	66.35
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	11.97
				Factor	**0.27**



Max Moment Formula = ML/2

Ultimate condition (W) = 1.50*10
= 15.00 kN

Apply Above Calculated Factor (Wf) = 15*0.27
= 4.05 kN

Maximum UltimateMoment (M_U)= Wf*L/2
= (4.05*6/2)
= 12.15 kNm

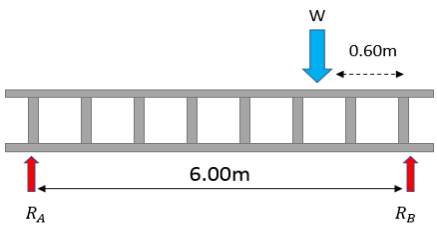
Maximum Allowable Moment (M_A)= 12.15/1.5
= 8.10 kNm

Moment values	**Ultimate**	**12.15 kNm**
	Allowable	**8.10 kNm**

Client :	Apollo Scaffold Services			
Project :	9 Inch Ladder Beam			
Element :	6.00m Ladder Beam Results			
Job No :	Z0112-01	By: mo	Date: Oct 20	
Doc No :	001B	Checked: mmr	Date: Oct 20	

Load Comb. 5 **End Shear** **(10kN load applied at a 0.6m distance from the support)**

Element	Action	Formula	Capacity	Calculated	Factor
Boom	Max Moment	$M_{c,Rd}$	0.66	0.85	0.78
	Shear	V_{Rd}	22.67	4.88	4.65
	Tension	$N_{o,Rd}$	66.82	16.49	4.05
	Compression	$N_{b,Rd}$	47.44	16.49	2.88
	Deflection	d	60.00	5.99	10.02
	Combined Axial	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.67
	Max Comp	$N_{b,Rd}$	47.44	16.49	2.88
	Moment	$M_{c,Rd}$	0.66	0.85	0.78
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.65
Vertical	Max Moment	$M_{c,Rd}$	0.66	1.29	0.51
	Shear	V_{Rd}	22.67	14.36	1.58
	Tension	$N_{o,Rd}$	66.82	0.01	6681.60
	Compression	$N_{b,Rd}$	66.15	0.04	1653.70
	Combined Axial	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.51
	Max Comp	$N_{b,Rd}$	66.15	4.94	13.39
	Moment	$M_{c,Rd}$	0.66	0.69	0.96
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.91
				Factor	**0.51**



Max Shear Formula = W*5.4/6

Ultimate condition (W) = 1.50*10
= 15.00 kN

Apply Above Calculated Factor (Wf) = 15*0.51
= 7.65 kN

Maximum Ultimate Shear (V_U)= Wf*5.4/6
= (7.65*5.4)/6
= 6.89 kN

Maximum Allowable Shear (V_A)= 6.89/1.50
= 4.59 kN

Shear values	**Ultimate**	**6.89 kN**
	Allowable	**4.59 kN**

6.00m Ladder Beam Analysis with restraints to compression chord at 1.00m c/c

Ladder Beam			
Loadcase No.		**Ultimate Moment**	**Allowable Moment**
1	UDL	10.80	7.20
2	Point	14.85	9.90
3	Third	11.70	7.80
4	Quarter	12.15	8.10

Loadcase No.		**Ultimate Shear**	**Allowable Shear**
5	End Shear	6.89	4.59

Max Allowable Moment = 7.20 kNm

Max Allowable Shear = 4.50 kN

From 6.00m Ladder Beam Analysis with restraints to compression chord at 1.00m c/c

For simply supported Apollo single Ladder Beam TO EUROCODE EN 1999-1

Allowable Bending Moment	7.20 kNm
Allowable Shear	4.50 kN

Allowable loads for load distributions

Type of Load		Clear span (m)										
		2	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Uniformly Distributed load	**kN/m**	14.40	6.40	3.60	2.30	1.60	1.18	0.90	0.71	0.58	0.48	0.40
Total UDL	**kN**	28.80	19.20	14.40	11.52	9.60	8.23	7.20	6.40	5.76	5.24	4.80
Single point load (mid Point)	**kN**	14.40	9.60	7.20	5.76	4.80	4.11	3.60	3.20	2.88	2.62	2.40
Two point loads (third points)	**Each kN**	10.80	7.20	5.40	4.32	3.60	3.09	2.70	2.40	2.16	1.96	1.80
Three pint loads (quarter points)	**Each kN**	7.20	4.80	3.60	2.88	2.40	2.06	1.80	1.60	1.44	1.31	1.20
		2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00	11.00	12.00
Uniformly Distributed load	**kN/m**	4.50	3.00	2.25	1.80	1.50	1.29	1.13	1.00	0.90	0.82	0.75
Total UDL	**kN**	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00
Single point load (mid Point)	**kN**	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00
Two point loads (third points)	**Each kN**	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50
Three pint loads (quarter points)	**Each kN**	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Type of Load		Clear span (m)										
		2	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Uniformly Distributed load	**kN/m**	4.50	3.00	2.25	1.80	1.50	1.18	0.90	0.71	0.58	0.48	0.40
Total UDL	**kN**	9.00	9.00	9.00	9.00	9.00	8.23	7.20	6.40	5.76	5.24	*4.80*
Single point load (mid Point)	**kN**	9.00	9.00	7.20	5.76	4.80	4.11	3.60	3.20	2.88	2.62	2.40
Two point loads (third points)	**Each kN**	4.50	4.50	4.50	4.32	3.60	3.09	2.70	2.40	2.16	1.96	1.80
Three point loads (quarter points)	**Each kN**	3.00	3.00	3.00	2.88	2.40	2.06	1.80	1.60	1.44	1.31	1.20

Notes:

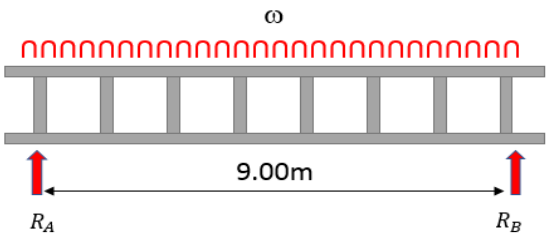
1. Above allowable loads may be increased by 1.11 for **wind loading only**
2. This table is provided as a guide only and assume all loads are applied at nodes. All scaffolds and structures should be checked by a qualified structural engineer. Loads indicated in italics and shaded are limited by shear.
3. Maximum capacity of a point load mid way between nodes is 7.80kN but overall buckling of the top chord should be checked if loads are placed other than at restrained loads. Compression chord restraint required at 1m c/c
4. Restraint point must support both top and bottom booms at restraint location.

9.00m Ladder Beam Results

Client :	Apollo Scaffold Services			
Project :	9 Inch Ladder Beam			
Element :	9.00m Ladder Beam Results			
Job No :	Z0112-01	By: mo	Date: Oct 20	
Doc No :	001B	Checked: mmr	Date: Oct 20	

Load Comb.1 **UDL load** **(10kN/m applied along beam)**

Element	Action	Formula	Capacity	Calculated	Factor
Boom	Moment	$M_{c,Rd}$	0.66	4.53	0.15
	Shear	V_{Rd}	22.67	22.23	1.02
	Tension	$N_{o,Rd}$	66.82	338.22	0.20
	Compression	$N_{b,Rd}$	47.44	338.22	0.14
	Deflection	d	90	320.00	0.28
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.08
Vertical	Moment	$M_{c,Rd}$	0.66	6.10	0.11
	Shear	V_{Rd}	22.67	67.80	0.33
	Tension	$N_{o,Rd}$	66.82	0.01	6681.60
	Compression	$N_{b,Rd}$	66.15	1.53	43.23
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.11
				Factor	**0.08**



(Note : Beam sketches do not reflect the real number of vertical tubes in beam)

Max Moment Formula = $ML^2/8$

Ultimate condition (W) = 1.5*10
= 15.00 kN

Apply Above Calculated Factor (Wf) = 15*0.08
= 1.20 kN

Maximum UltimateMoment (M_U)= $Wf*L^2/8$
= (1.20*9^2)/8
= 12.15 kNm

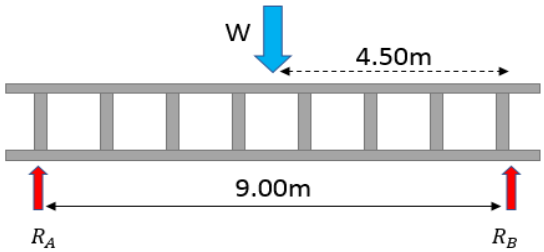
Maximum Allowable Moment (M_A)= 12.15/1.50
= 8.10 kNm

Moment values	**Ultimate**	**12.15 kNm**
	Allowable	**8.10 kNm**

Client :	Apollo Scaffold Services			
Project :	9 Inch Ladder Beam			
Element :	9.00m Ladder Beam Results			
Job No :	Z0112-01	By: mo	Date: Oct 20	
Doc No :	001B	Checked: mmr	Date: Oct 20	

Load Comb. 2 **Point load** **(10kN load applied at midspan of beam)**

Element	Action	Formula	Capacity	Calculated	Factor
Boom	Moment	$M_{c,Rd}$	0.66	0.64	1.04
	Shear	V_{Rd}	22.67	2.61	8.69
	Tension	$N_{o,Rd}$	66.82	58.90	1.13
	Compression	$N_{b,Rd}$	47.44	58.90	0.81
	Deflection	d	90.00	70.80	1.27
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.49
Vertical	Max Moment	$M_{c,Rd}$	0.66	0.77	0.86
	Shear	V_{Rd}	22.67	8.52	2.66
	Tension	$N_{o,Rd}$	66.82	0.01	6681.60
	Compression	$N_{b,Rd}$	66.15	0.01	6614.78
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.86
	Max Comp	$N_{b,Rd}$	66.15	4.94	13.39
	Moment	$M_{c,Rd}$	0.66	0.01	66.35
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	11.97
				Factor	**0.49**



Max Moment Formula = ML/4

Ultimate condition (W) = 1.50*10
= 15.00 kN

Apply Above Calculated Factor (Wf) = 15*0.49
= 7.35 kN

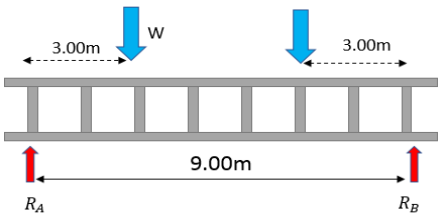
Maximum UltimateMoment (M_U)= Wf*L/4
= 7.35*9/4
= 16.54 kNm

Maximum Allowable Moment (M_A)= 16.54/1.50
= 11.03 kNm

Moment values	**Ultimate**	**16.54 kNm**
	Allowable	**11.03 kNm**

Load Comb. 3 **PL at 1/3 points** **(10kN load applied at each of the two third points)**

Element	Action	Formula	Capacity	Calculated	Factor
Boom	Max Moment	$M_{c,Rd}$	0.66	1.14	0.58
	Shear	V_{Rd}	22.67	5.32	4.26
	Tension	$N_{o,Rd}$	66.82	101.23	0.66
	Compression	$N_{b,Rd}$	47.44	0.01	4743.94
	Deflection	d	90.00	95.87	0.94
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.58
	Max Comp	$N_{b,Rd}$	47.44	101.23	0.47
	Moment	$M_{c,Rd}$	0.66	1.14	0.58
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.29
Vertical	Max Moment	$M_{c,Rd}$	0.66	1.57	0.42
	Shear	V_{Rd}	22.67	17.43	1.30
	Tension	$N_{o,Rd}$	66.82	0.01	6681.60
	Compression	$N_{b,Rd}$	66.15	0.01	6614.78
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.42
	Max Comp	$N_{b,Rd}$	66.15	4.91	13.47
	Moment	$M_{c,Rd}$	0.66	0.69	0.96
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.91
				Factor	**0.29**



Max Moment Formula = ML/3

Ultimate condition (W) = 1.50*10
= 15.00 kN

Apply Above Calculated Factor (Wf) = 15*0.29
= 4.35 kN

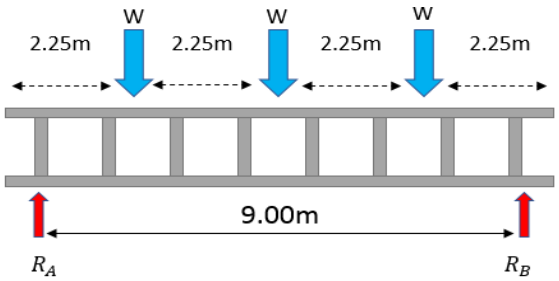
Maximum UltimateMoment (M_U)= Wf*L/3
= (4.35*9)/3
= 13.05 kNm

Maximum Allowable Moment (M_A)= 13.05/1.50
= 8.70 kNm

Moment values	**Ultimate**	**13.05 kNm**
	Allowable	**8.70 kNm**

Load Comb. 4 **PL at 1/4 points** **(10kN load applied at each of the three quarter points)**

Element	Action	Formula	Capacity	Calculated	Factor
Boom	Moment	$M_{c,Rd}$	0.66	1.62	0.41
	Shear	V_{Rd}	22.67	7.61	2.98
	Tension	$N_{o,Rd}$	66.82	138.23	0.48
	Compression	$N_{b,Rd}$	47.44	138.23	0.34
	Deflection	d	90.00	134.18	0.67
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.20
Vertical	Max Moment	$M_{c,Rd}$	0.66	2.25	0.29
	Shear	V_{Rd}	22.67	24.95	0.91
	Tension	$N_{o,Rd}$	66.82	0.01	6681.60
	Compression	$N_{b,Rd}$	66.15	0.01	6614.78
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.29
	Max Comp	$N_{b,Rd}$	66.15	4.94	13.39
	Moment	$M_{c,Rd}$	0.66	1.49	0.45
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.43
				Factor	**0.20**



Max Moment Formula = ML/2

Ultimate condition (W) = 1.50*10
= 15.00 kN

Apply Above Calculated Factor (Wf) = 15*0.20
= 3.00 kN

Maximum UltimateMoment (M_U)= Wf*L/2
= (3.00*9/2)
= 13.50 kNm

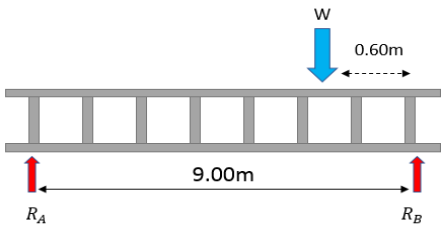
Maximum Allowable Moment (M_A)= 13.50/1.5
= 9.00 kNm

Moment values	**Ultimate**	**13.50 kNm**
	Allowable	**9.00 kNm**

Client :	Apollo Scaffold Services			
Project :	9 Inch Ladder Beam			
Element :	9.00m Ladder Beam Results			
Job No :	Z0112-01	By: mo	Date: Oct 20	
Doc No :	001B	Checked: mmr	Date: Oct 20	

Load Comb. 5 **End Shear** **(10kN load applied at a 0.6m distance from the support)**

Element	Action	Formula	Capacity	Calculated	Factor
Boom	Max Moment	$M_{c,Rd}$	0.66	0.89	0.75
	Shear	V_{Rd}	22.67	5.04	4.50
	Tension	$N_{o,Rd}$	66.82	20.23	3.30
	Compression	$N_{b,Rd}$	47.44	20.23	2.35
	Deflection	d	90.00	6.77	13.29
	Combined Axial	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.62
	Max Comp	$N_{b,Rd}$	47.44	20.23	2.35
	Moment	$M_{c,Rd}$	0.66	0.89	0.75
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.60
Vertical	Max Moment	$M_{c,Rd}$	0.66	1.34	0.50
	Shear	V_{Rd}	22.67	14.88	1.52
	Tension	$N_{o,Rd}$	66.82	0.01	6681.60
	Compression	$N_{b,Rd}$	66.15	0.04	1653.70
	Combined Axial	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.50
	Max Comp	$N_{b,Rd}$	66.15	4.94	13.39
	Moment	$M_{c,Rd}$	0.66	0.74	0.90
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.85
				Factor	**0.51**



Max Shear Formula = W*8.40/9

Ultimate condition (W) = 1.50*10
= 15.00 kN

Apply Above Calculated Factor (Wf) = 15*0.51
= 7.65 kN

Maximum Ultimate Shear (V_U)= Wf*8.40/9
= (7.65*8.40)/9
= 7.14 kN

Maximum Allowable Shear (V_A)= 7.14/1.50
= 4.76 kN

Shear values	**Ultimate**	**7.14 kN**
	Allowable	**4.76 kN**

9.00m Ladder Beam Analysis with restraints to compression chord at 1.00m c/c

Ladder Beam			
Loadcase No.		**Ultimate Moment**	**Allowable Moment**
1	UDL	12.15	8.10
2	Point	16.54	11.03
3	Third	13.05	8.70
4	Quarter	13.50	9.00

Loadcase No.		**Ultimate Shear**	**Allowable Shear**
5	End Shear	7.14	4.76

Max Allowable Moment = 8.10 kNm

Max Allowable Shear = 4.70 kN

From 9.00m Ladder Beam Analysis with restraints to compression chord at 1.00m c/c

For simply supported Apollo single Ladder Beam TO EUROCODE EN 1999-1

Allowable Bending Moment	8.10 kNm
Allowable Shear	4.70 kN

Allowable loads for load distributions

Type of Load		Clear span (m)										
		2	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Uniformly Distributed load	**kN/m**	16.20	7.20	4.05	2.59	1.80	1.32	1.01	0.80	0.65	0.54	0.45
Total UDL	**kN**	32.40	21.60	16.20	12.96	10.80	9.26	8.10	7.20	6.48	5.89	5.40
Single point load (mid Point)	**kN**	16.20	10.80	8.10	6.48	5.40	4.63	4.05	3.60	3.24	2.95	2.70
Two point loads (third points)	**Each kN**	12.15	8.10	6.08	4.86	4.05	3.47	3.04	2.70	2.43	2.21	2.03
Three pint loads (quarter points)	**Each kN**	8.10	5.40	4.05	3.24	2.70	2.31	2.03	1.80	1.62	1.47	1.35
		2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00	11.00	12.00
Uniformly Distributed load	**kN/m**	4.70	3.13	2.35	1.88	1.57	1.34	1.18	1.04	0.94	0.85	0.78
Total UDL	**kN**	9.40	9.40	9.40	9.40	9.40	9.40	9.40	9.40	9.40	9.40	9.40
Single point load (mid Point)	**kN**	9.40	9.40	9.40	9.40	9.40	9.40	9.40	9.40	9.40	9.40	9.40
Two point loads (third points)	**Each kN**	4.70	4.70	4.70	4.70	4.70	4.70	4.70	4.70	4.70	4.70	4.70
Three pint loads (quarter points)	**Each kN**	3.13	3.13	3.13	3.13	3.13	3.13	3.13	3.13	3.13	3.13	3.13
Type of Load		Clear span (m)										
		2	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Uniformly Distributed load	**kN/m**	4.70	3.13	2.35	1.88	1.57	1.32	1.01	0.80	0.65	0.54	0.45
Total UDL	**kN**	9.40	9.40	9.40	9.40	9.40	9.26	8.10	7.20	6.48	5.89	*5.40*
Single point load (mid Point)	**kN**	9.40	9.40	8.10	6.48	5.40	4.63	4.05	3.60	3.24	2.95	2.70
Two point loads (third points)	**Each kN**	4.70	4.70	4.70	4.70	4.05	3.47	3.04	2.70	2.43	2.21	2.03
Three point loads (quarter points)	**Each kN**	3.13	3.13	3.13	3.13	2.70	2.31	2.03	1.80	1.62	1.47	1.35

Notes:

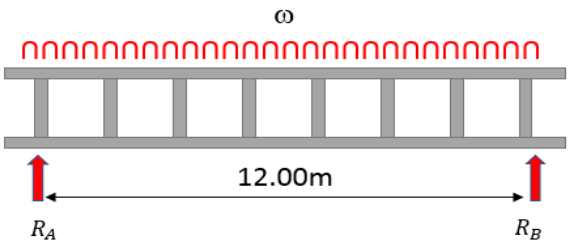
1. Above allowable loads may be increased by 1.11 for **wind loading only**
2. This table is provided as a guide only and assume all loads are applied at nodes. All scaffolds and structures should be checked by a qualified structural engineer. Loads indicated in italics and shaded are limited by shear.
3. Maximum capacity of a point load mid way between nodes is 7.80kN but overall buckling of the top chord should be checked if loads are placed other than at restrained loads. Compression chord restraint required at 1m c/c
4. Restraint point must support both top and bottom booms at restraint location.

12.00m Ladder Beam Results

Client :	Apollo Scaffold Services			
Project :	9 Inch Ladder Beam			
Element :	12.00m Ladder Beam Results			
Job No :	Z0112-01	By: mo	Date: Oct 20	
Doc No :	001B	Checked: mmr	Date: Oct 20	

Load Comb.1 **UDL load** **(10kN/m applied along beam)**

Element	Action	Formula	Capacity	Calculated	Factor
Boom	Moment	$M_{c,Rd}$	0.66	6.49	0.10
	Shear	V_{Rd}	22.67	29.89	0.76
	Tension	$N_{o,Rd}$	66.82	619.34	0.11
	Compression	$N_{b,Rd}$	47.44	619.34	0.08
	Deflection	d	120	883.44	0.14
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.05
Vertical	Moment	$M_{c,Rd}$	0.66	8.34	0.08
	Shear	V_{Rd}	22.67	92.66	0.24
	Tension	$N_{o,Rd}$	66.82	0.01	6681.60
	Compression	$N_{b,Rd}$	66.15	1.53	43.23
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.08
				Factor	**0.05**



(Note : Beam sketches do not reflect the real number of vertical tubes in beam)

Max Moment Formula = $ML^2/8$

Ultimate condition (W) = 1.5*10
= 15.00 kN

Apply Above Calculated Factor (Wf) = 15*0.05
= 0.75 kN

Maximum UltimateMoment (M_U)= $Wf*L^2/8$
= (0.75*12^2)/8
= 13.50 kNm

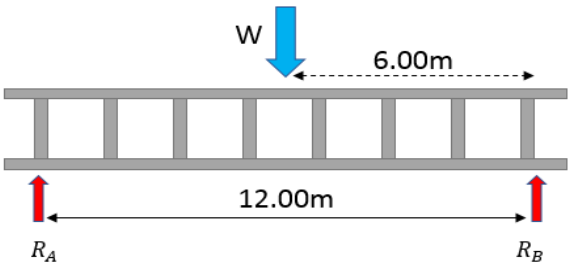
Maximum Allowable Moment (M_A)= 13.50/1.50
= 9.00 kNm

Moment values	**Ultimate**	**13.50 kNm**
	Allowable	**9.00 kNm**

Client :	Apollo Scaffold Services			
Project :	9 Inch Ladder Beam			
Element :	12.00m Ladder Beam Results			
Job No :	Z0112-01	By: mo	Date: Oct 20	
Doc No :	001B	Checked: mmr	Date: Oct 20	

Load Comb. 2 **Point load** **(10kN load applied at midspan of beam)**

Element	Action	Formula	Capacity	Calculated	Factor
Boom	Moment	$M_{c,Rd}$	0.66	0.69	0.96
	Shear	V_{Rd}	22.67	2.65	8.56
	Tension	$N_{o,Rd}$	66.82	80.92	0.83
	Compression	$N_{b,Rd}$	47.44	80.92	0.59
	Deflection	d	120.00	147.97	0.81
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.39
Vertical	Max Moment	$M_{c,Rd}$	0.66	0.79	0.84
	Shear	V_{Rd}	22.67	8.65	2.62
	Tension	$N_{o,Rd}$	66.82	0.01	6681.60
	Compression	$N_{b,Rd}$	66.15	0.01	6614.78
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.84
	Max Comp	$N_{b,Rd}$	66.15	4.94	13.39
	Moment	$M_{c,Rd}$	0.66	0.01	66.35
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	11.97
				Factor	**0.39**



Max Moment Formula = ML/4

Ultimate condition (W) = 1.50*10
= 15.00 kN

Apply Above Calculated Factor (Wf) = 15*0.39
= 5.85 kN

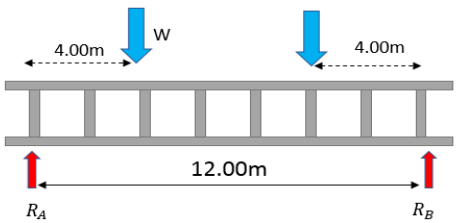
Maximum UltimateMoment (M_U)= Wf*L/4
= 5.85*12/4
= 17.55 kNm

Maximum Allowable Moment (M_A)= 17.55/1.50
= 11.70 kNm

Moment values	**Ultimate**	**17.55 kNm**
	Allowable	**11.70 kNm**

Load Comb. 3 **PL at 1/3 points** **(10kN load applied at each of the two third points)**

Element	Action	Formula	Capacity	Calculated	Factor
Boom	Max Moment	$M_{c,Rd}$	0.66	1.20	0.55
	Shear	V_{Rd}	22.67	5.15	4.40
	Tension	$N_{o,Rd}$	66.82	0.01	6681.60
	Compression	$N_{b,Rd}$	47.44	138.62	0.34
	Deflection	d	120.00	207.68	0.58
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.23
	Max Comp	$N_{b,Rd}$	47.44	138.62	0.34
	Moment	$M_{c,Rd}$	0.66	1.20	0.55
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.23
Vertical	Max Moment	$M_{c,Rd}$	0.66	1.52	0.44
	Shear	V_{Rd}	22.67	16.86	1.34
	Tension	$N_{o,Rd}$	66.82	0.01	6681.60
	Compression	$N_{b,Rd}$	66.15	0.01	6614.78
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.44
	Max Comp	$N_{b,Rd}$	66.15	4.94	13.39
	Moment	$M_{c,Rd}$	0.66	0.76	0.87
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.83
				Factor	**0.23**



Max Moment Formula = ML/3

Ultimate condition (W) = 1.50*10
= 15.00 kN

Apply Above Calculated Factor (Wf) = 15*0.23
= 3.45 kN

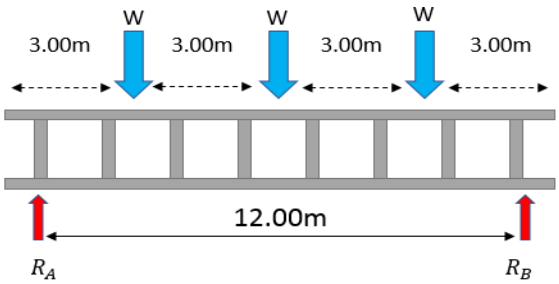
Maximum UltimateMoment (M_U)= Wf*L/3
= (3.45*12)/3
= 13.80 kNm

Maximum Allowable Moment (M_A)= 13.80/1.50
= 9.20 kNm

Moment values	**Ultimate**	**13.80 kNm**
	Allowable	**9.20 kNm**

Load Comb. 4 **PL at 1/4 points** **(10kN load applied at each of the three quarter points)**

Element	Action	Formula	Capacity	Calculated	Factor
Boom	Moment	$M_{c,Rd}$	0.66	1.76	0.38
	Shear	V_{Rd}	22.67	7.65	2.96
	Tension	$N_{o,Rd}$	66.82	0.01	6681.60
	Compression	$N_{b,Rd}$	47.44	195.49	0.24
	Deflection	d	120.00	292.15	0.41
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.16
Vertical	Max Moment	$M_{c,Rd}$	0.66	2.26	0.29
	Shear	V_{Rd}	22.67	25.08	0.90
	Tension	$N_{o,Rd}$	66.82	0.01	6681.60
	Compression	$N_{b,Rd}$	66.15	0.01	6614.78
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.29
	Max Comp	$N_{b,Rd}$	66.15	4.94	13.39
	Moment	$M_{c,Rd}$	0.66	1.53	0.43
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.42
				Factor	**0.16**



Max Moment Formula = ML/2

Ultimate condition (W) = 1.50*10
= 15.00 kN

Apply Above Calculated Factor (Wf) = 15*0.16
= 2.40 kN

Maximum UltimateMoment (M_U)= Wf*L/2
= (2.40*12/2)
= 14.40 kNm

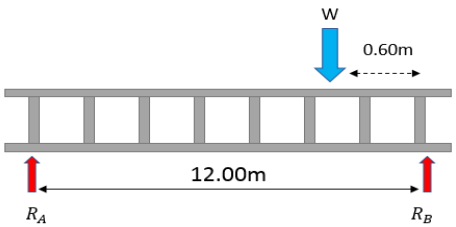
Maximum Allowable Moment (M_A)= 14.40/1.5
= 9.60 kNm

Moment values	**Ultimate**	**14.40 kNm**
	Allowable	**9.60 kNm**

Client :	Apollo Scaffold Services			
Project :	9 Inch Ladder Beam			
Element :	12.00m Ladder Beam Results			
Job No :	Z0112-01	By: mo	Date: Oct 20	
Doc No :	001B	Checked: mmr	Date: Oct 20	

Load Comb. 5 **End Shear** **(10kN load applied at a 0.6m distance from the support)**

Element	Action	Formula	Capacity	Calculated	Factor
Boom	Max Moment	$M_{c,Rd}$	0.66	0.91	0.73
	Shear	V_{Rd}	22.67	5.12	4.43
	Tension	$N_{o,Rd}$	66.82	0.01	6681.60
	Compression	$N_{b,Rd}$	47.44	23.03	2.06
	Deflection	d	120.00	11.18	10.73
	Combined Axial	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.59
	Max Comp	$N_{b,Rd}$	47.44	23.03	2.06
	Moment	$M_{c,Rd}$	0.66	0.91	0.73
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.57
Vertical	Max Moment	$M_{c,Rd}$	0.66	1.36	0.49
	Shear	V_{Rd}	22.67	15.13	1.50
	Tension	$N_{o,Rd}$	66.82	0.01	6681.60
	Compression	$N_{b,Rd}$	66.15	0.04	1653.70
	Combined Axial	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.49
	Max Comp	$N_{b,Rd}$	66.15	4.94	13.39
	Moment	$M_{c,Rd}$	0.66	0.76	0.87
	Combined	$(N_{ed}/N_{Rd})^{1.3} + [(M_{ed,x}/M_{rd,x})^{1.7}]^{0.6} < 1.0$		1.00	0.83
				Factor	**0.51**



Max Shear Formula = W*11.40/12.00

Ultimate condition (W) = 1.50*10
= 15.00 kN

Apply Above Calculated Factor (Wf) = 15*0.51
= 7.65 kN

Maximum Ultimate Shear (V_U)= Wf*11.40/12
= (7.65*11.40)/12.00
= 7.27 kN

Maximum Allowable Shear (V_A)= 7.27/1.50
= 4.85 kN

Shear values	**Ultimate**	**7.27 kN**
	Allowable	**4.85 kN**

12.00m Ladder Beam Analysis with restraints to compression chord at 1.00m c/c

Ladder Beam

Loadcase No.		Ultimate Moment	Allowable Moment
1	UDL	13.50	9.00
2	Point	17.55	11.70
3	Third	13.80	9.20
4	Quarter	14.40	9.60

Loadcase No.		Ultimate Shear	Allowable Shear
5	End Shear	7.27	4.85

Max Allowable Moment = 9.00 kNm

Max Allowable Shear = 4.80 kN

From 12.00m Ladder Beam Analysis with restraints to compression chord at 1.00m c/c

For simply supported Apollo single Ladder Beam TO EUROCODE EN 1999-1

Allowable Bending Moment	9.00 kNm
Allowable Shear	4.80 kN

Allowable loads for load distributions

Type of Load		Clear span (m)										
		2	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Uniformly Distributed load	**kN/m**	18.00	8.00	4.50	2.88	2.00	1.47	1.13	0.89	0.72	0.60	0.50
Total UDL	**kN**	36.00	24.00	18.00	14.40	12.00	10.29	9.00	8.00	7.20	6.55	6.00
Single point load (mid Point)	**kN**	18.00	12.00	9.00	7.20	6.00	5.14	4.50	4.00	3.60	3.27	3.00
Two point loads (third points)	**Each kN**	13.50	9.00	6.75	5.40	4.50	3.86	3.38	3.00	2.70	2.45	2.25
Three pint loads (quarter points)	**Each kN**	9.00	6.00	4.50	3.60	3.00	2.57	2.25	2.00	1.80	1.64	1.50
		2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00	11.00	12.00
Uniformly Distributed load	**kN/m**	4.80	3.20	2.40	1.92	1.60	1.37	1.20	1.07	0.96	0.87	0.80
Total UDL	**kN**	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60
Single point load (mid Point)	**kN**	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60
Two point loads (third points)	**Each kN**	4.80	4.80	4.80	4.80	4.80	4.80	4.80	4.80	4.80	4.80	4.80
Three pint loads (quarter points)	**Each kN**	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20
Type of Load		Clear span (m)										
		2	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Uniformly Distributed load	**kN/m**	4.80	3.20	2.40	1.92	1.60	1.37	1.13	0.89	0.72	0.60	0.50
Total UDL	**kN**	9.60	9.60	9.60	9.60	9.60	9.60	9.00	8.00	7.20	6.55	*6.00*
Single point load (mid Point)	**kN**	9.60	9.60	9.00	7.20	6.00	5.14	4.50	4.00	3.60	3.27	3.00
Two point loads (third points)	**Each kN**	4.80	4.80	4.80	4.80	4.50	3.86	3.38	3.00	2.70	2.45	2.25
Three point loads (quarter points)	**Each kN**	3.20	3.20	3.20	3.20	3.00	2.57	2.25	2.00	1.80	1.64	1.50

Notes:

1. Above allowable loads may be increased by 1.11 for **wind loading only**
2. This table is provided as a guide only and assume all loads are applied at nodes. All scaffolds and structures should be checked by a qualified structural engineer. Loads indicated in italics and shaded are limited by shear.
3. Maximum capacity of a point load mid way between nodes is 7.80kN but overall buckling of the top chord should be checked if loads are placed other than at restrained loads. Compression chord restraint required at 1m c/c
4. Restraint point must support both top and bottom booms at restraint location.

Overall Graded Results for Allowable Working Loads on an Ladder Beam

For simply supported Apollo Ladder Beam with a compression chord restraint at 1m intervals

Test Results

	Span(m)			
	3	6	9	12
Allowable Moment	3.9	7.2	8.1	9.0
Allowable Shear	4.0	4.5	4.7	4.8

Allowable loads for load distributions from results

		Clear span (m)			
		3	6	9	12
Uniformly Distributed load	**kN/m**	2.67	1.50	0.80	0.50
Total UDL	**kN**	8.00	9.00	7.20	6.00
Single point load (mid Point)	**kN**	5.20	4.80	3.60	3.00
Two point loads (third points)	**Each kN**	3.90	3.60	2.70	2.25
Three point loads (quarter points)	**Each kN**	2.60	2.40	1.80	1.50

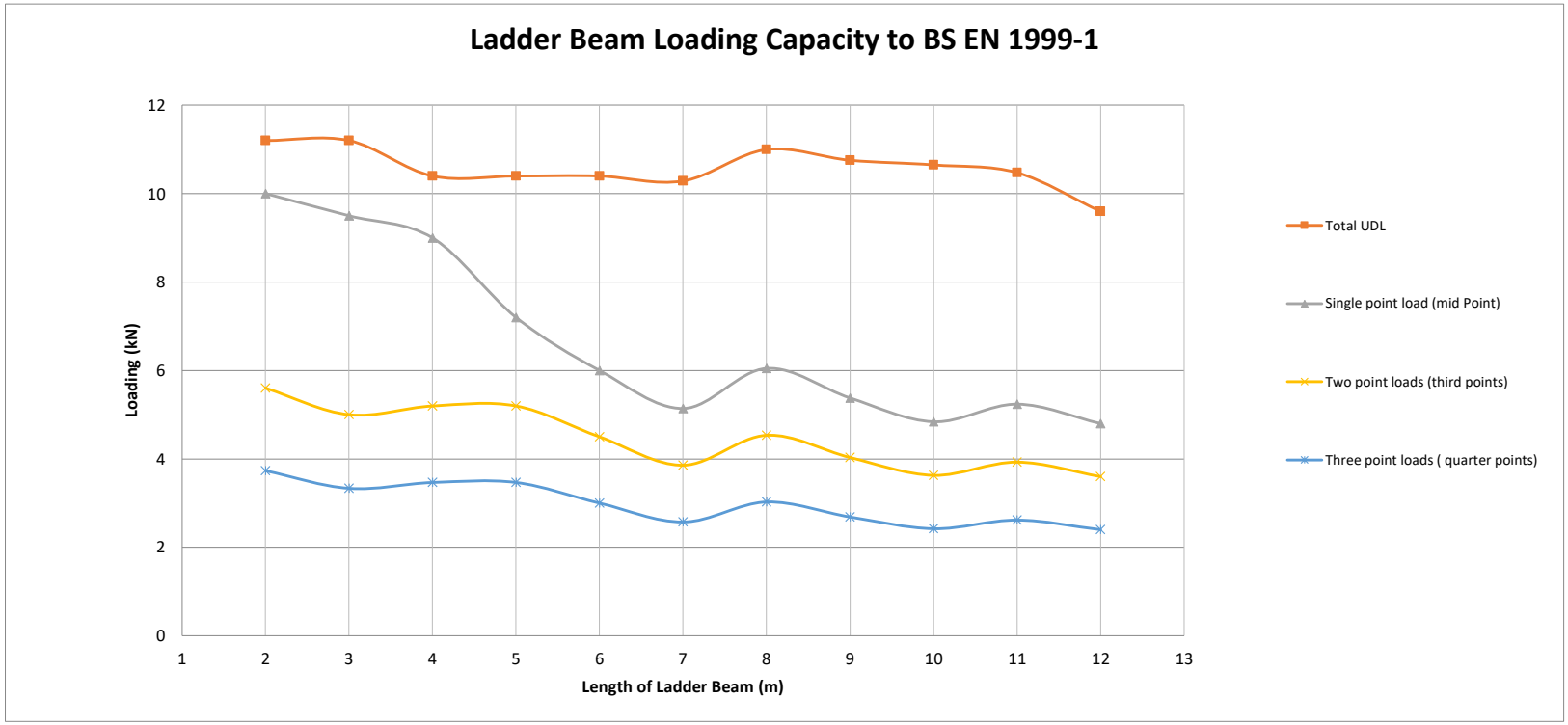
Extrapolated Allowable loads for load distributions

Type of Load		Clear span (m)										
		2	3	4	5	6	7	8	9	10	11	12
Uniformly Distributed load	**kN/m**	4.00	2.67	2.25	1.80	1.50	1.18	1.01	0.80	0.65	0.60	0.50
Total UDL	**kN**	8.00	8.00	9.00	9.00	9.00	8.23	8.10	7.20	6.48	6.55	6.00
Single point load (mid Point)	**kN**	7.80	5.20	7.20	5.76	4.80	4.11	4.05	3.60	3.24	3.27	3.00
Two point loads (third points)	**Each kN**	4.00	3.90	4.50	4.32	3.60	3.09	3.04	2.70	2.43	2.45	2.25
Three point loads (quarter points)	**Each kN**	2.67	2.60	3.00	2.88	2.40	2.06	2.03	1.80	1.62	1.64	1.50

Notes:

1. Above allowable loads may be increased by 1.11 for **wind loading only**
2. This table is provided as a guide only and assume all loads are applied at nodes. All scaffolds and structures should be checked by a qualified structural engineer. Loads indicated in italics and shaded are limited by shear.
3. Maximum capacity of a point load mid way between nodes is 7.80kN but overall buckling of the top chord should be checked if loads are placed other than at restrained loads. Compression chord restraint required at 1m c/c
4. Restraint point must support both top and bottom booms at restraint location.

Graph Summary of Allowable Working Loads for a Ladder Beam to BS EN 1999-1-1



ALANWHITEDESIGN
INSPIRED ENGINEERING

REGISTERED IN SCOTLAND:
Company No. SC349820
17-19 Hill Street, Kilmarnock, KA3 1HA

PHONE: 01563 594621
FAX: 01563 593056
enquiry@alanwhitedesign.com
www.alanwhitedesign.com