ALANWHITEDESIGN
INSPIRED ENGINEERING

22207-02-001A
APOLLO SCAFFOLD SERVICES LTD
160MM LADDER BOX BEAM
CANTILEVERED LIFTING BEAM
DESIGN CALCULATIONS

OCT 2022

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

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DOCUMENT REVISION HISTORY

REV.	DESCRIPTION	AUTHOR	DATE	CHECKED	APPROVED
A	Initial issue	PL	20-10-2022	ES	MR

TEMPORARY WORKS DESIGN CERTIFICATE

Project: 160mm Ladder Box Beam

Client: Apollo Scaffold Services Ltd

Design Brief Issued: Yes

Design Brief Reference: Email

Does the design comply with the brief: Yes

Name	Paul Lynch
Title	Design Engineer
Signature	Paul Lynch
	To be signed by the Temporary Works Designer or other person authorised to sign on behalf of the organisation responsible for the Design of the Temporary Works.

Documents Produced
22207-02-001A
22207-02-101A

Notes:
Max load on beam is 350kg SWL.
Double box ties must be utilised to fix lifting beams to existing.

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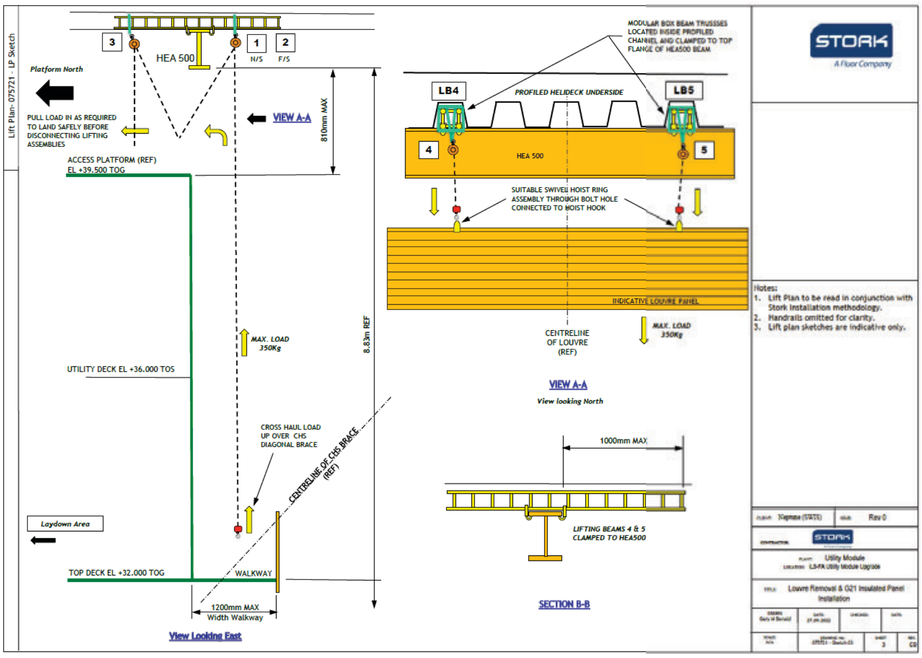
BRIEF

To provide a design check for the use of a 160mm Ladder Box Beam to be used as a lifting beam on behalf of Apollo Scaffold Services.

LAYOUT

Layout as per client provide drawing below:



DESIGN STANDARDS USED

BS EN 1990 +A1:2005 Basis of Structural design

NA to BS EN 1990 +A1:2005 UK National Annex to Basis of Structural design

BS EN 1999-1-1 Design of Aluminium Structures – General rules

NA to BS EN 1999-1-1 UK National Annex to Design of Aluminium Structures – General rules

BS 5975:2019 Code of practice for temporary works procedures and the permissible stress design of falsework

BS EN 13155:2020 Crane - Safety - Non-fixed load lifting attachments

INFORMATION RECEIVED

Ladder truss beam requirement sketch.pdf

Stork Lift beam sketch.pdf

LOADING

Max lifting load on one beam at any time is 350kg.

STABILITY

Ladder Box beam is tied to existing steel beams via double box ties.

ASSUMPTIONS

160mm ladder box beam to be used.

Max load on beam is 350kg.

Class A couplers used throughout.

Aluminium scaffold beams to be used for box ties.

EXCLUSIONS

Report does not include check of existing structure for imposed loadings.

Report does not cover lifting operations including connection to box beam and lifting plans.

SUMMARY

Gravlock does not work as per client provided layout, AWD suggest using a double box tie arrangement.

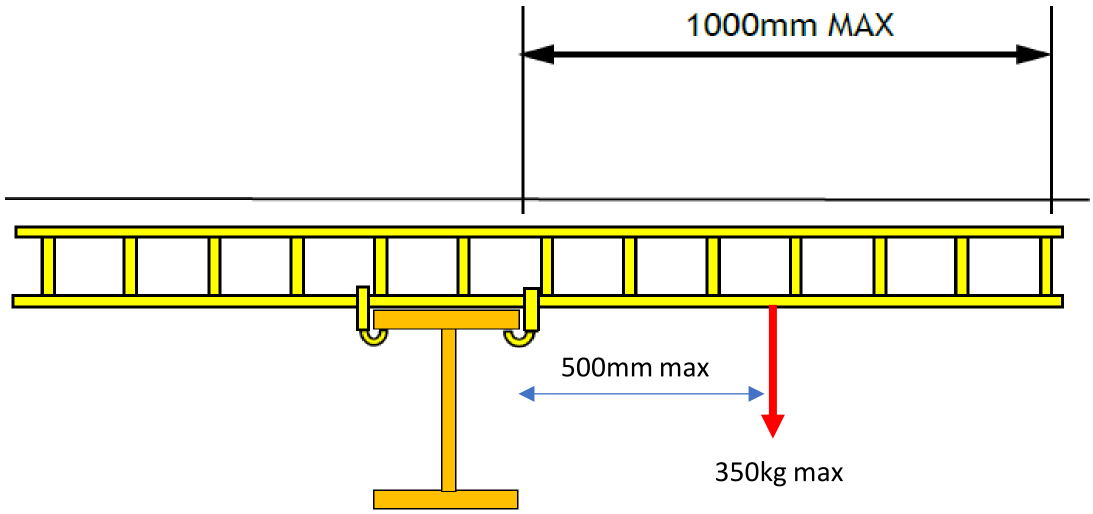
Cantilevered ladder beam passes design checks.

Double box ties must be utilised to fix lifting beams to existing.

RECOMMENDATIONS

N/A.

Layout

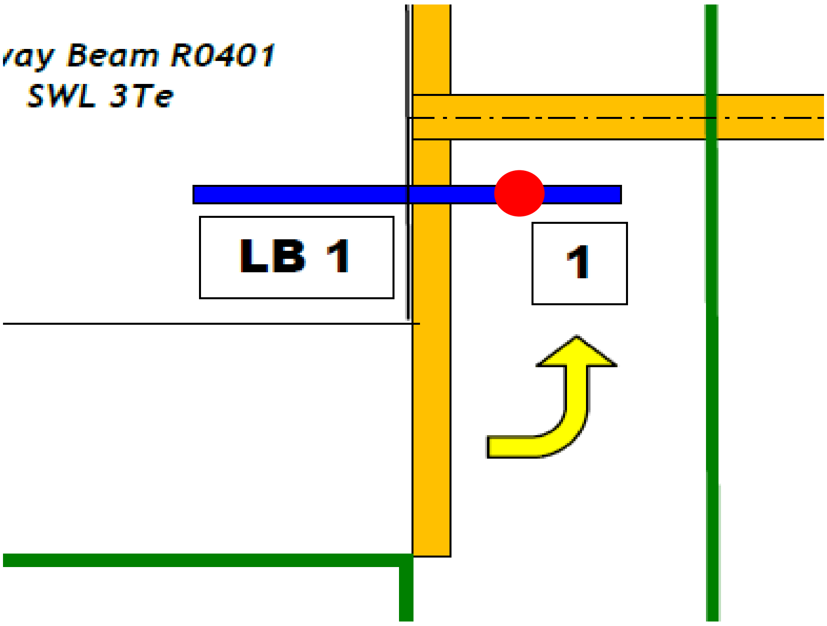


Loading

Lifting Plan detailed by client below (Appendix B):

Lift point 1 on LB 1 will lift load vertical
Xhaul between LB1 & 2
Lift point 2 on LB 2 will x haul load across 2m until suspended on LB2
Disconnect LP1 on LB1
Lift point 2 to lift load vertical to roof
Lift point 3 on LB 2 connected to load and tail load inboard onto roof.

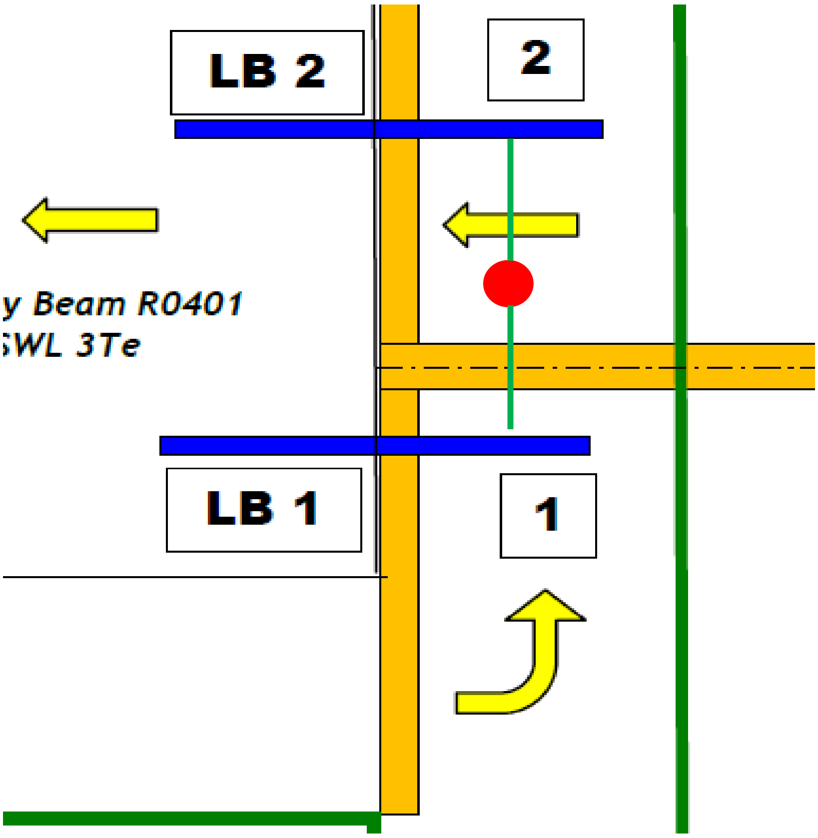
Loading Scenario 1:



Total Lifting Load applied vertically.

Max Vertical Load =	350.00	kg
=	3.50	kN
5% Notional Horizontal Load =	0.18	kN

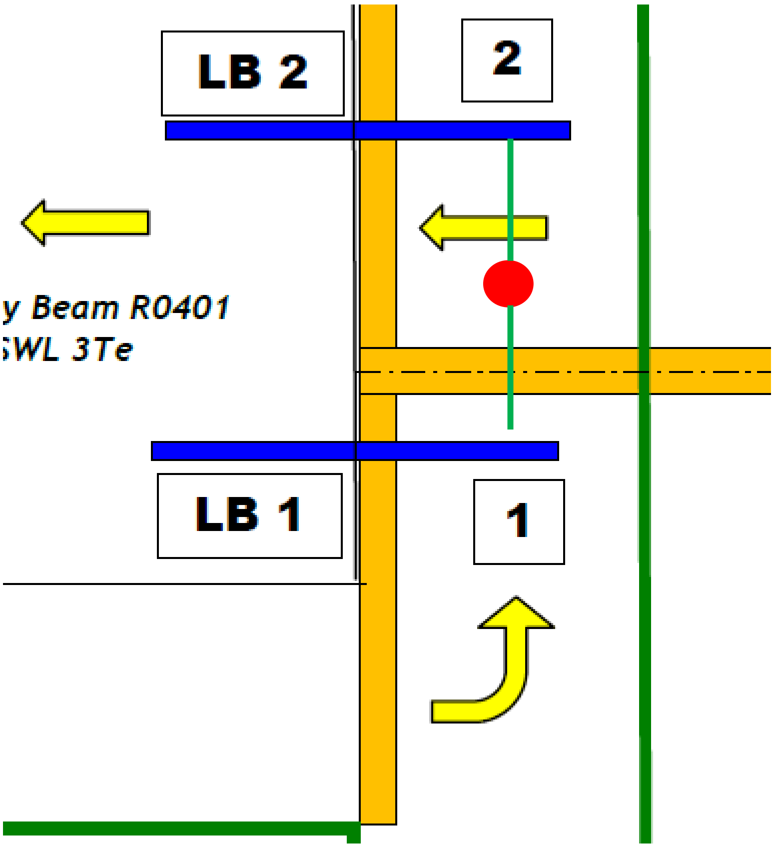
Loading Scenario 2:



Load applied at 45° between 1 and 2.

Max Vertical Load =	350.00	kg
=	3.50	kN
θ =	45	°
Horizontal Load =	3.50sin(45)	
=	2.47	kN
Vertical Load =	3.50cos(45)	
=	2.47	kN

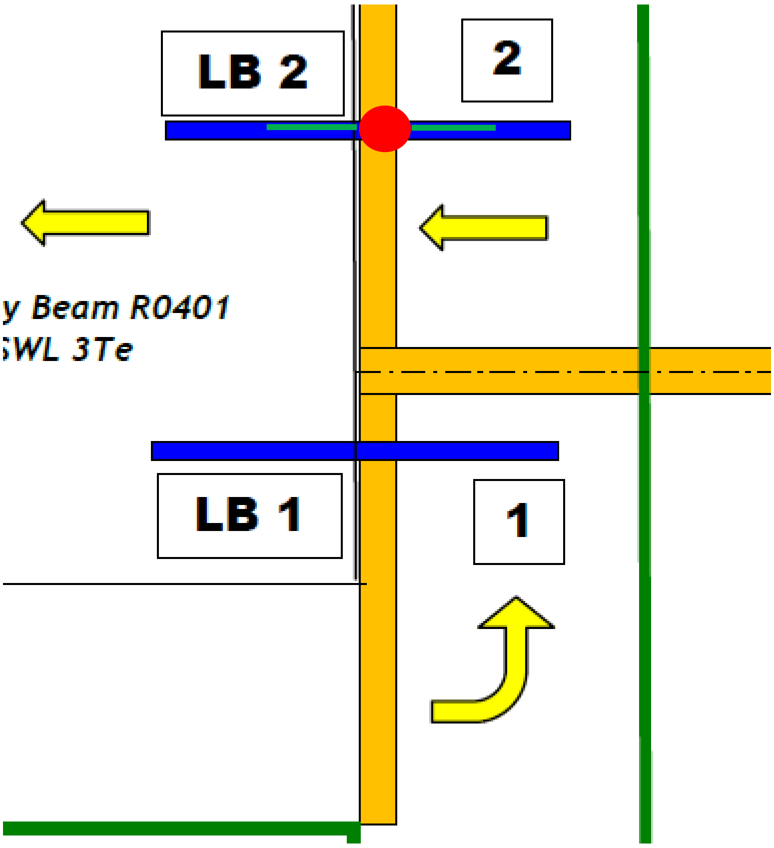
Loading Scenario 3:



Load applied at 60° between 1 and 2.

Max Vertical Load =	350.00	kg
=	3.50	kN
θ =	60	°
Horizontal Load =	3.50sin(60)	
=	3.03	kN
Vertical Load =	3.50cos(60)	
=	1.75	kN

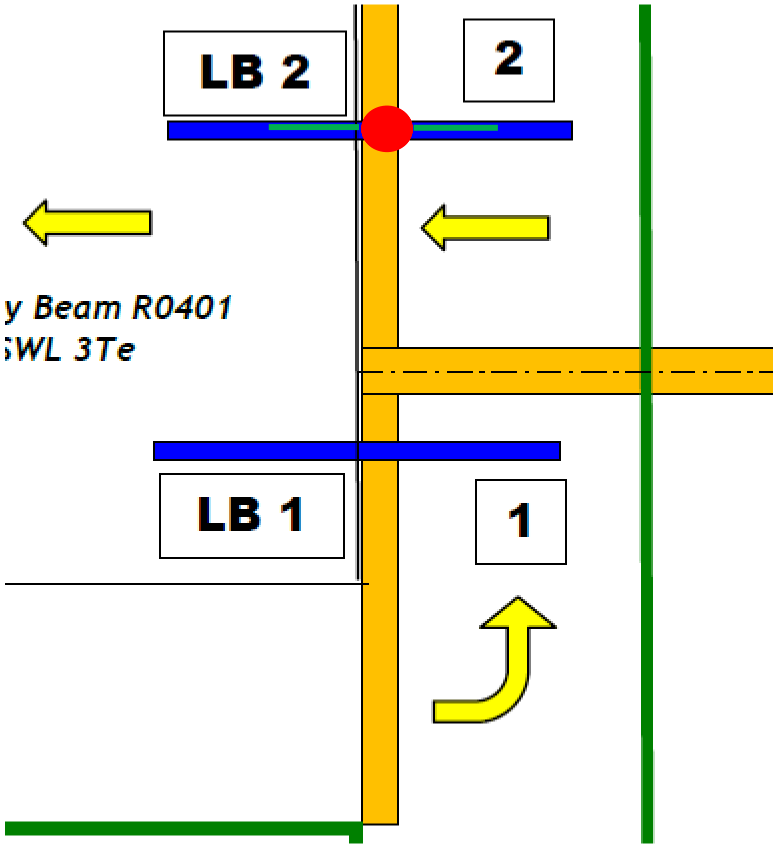
Loading Scenario 4:



Load applied at 45° between lifting points on LB2.

Max Vertical Load =	350.00	kg
=	3.50	kN
2No Lifting Points =	1.75	kN
θ =	45	°
Horizontal Load =	1.75sin(45)	
=	1.24	kN
Vertical Load =	1.75cos(45)	
=	1.24	kN

Loading Scenario 5:

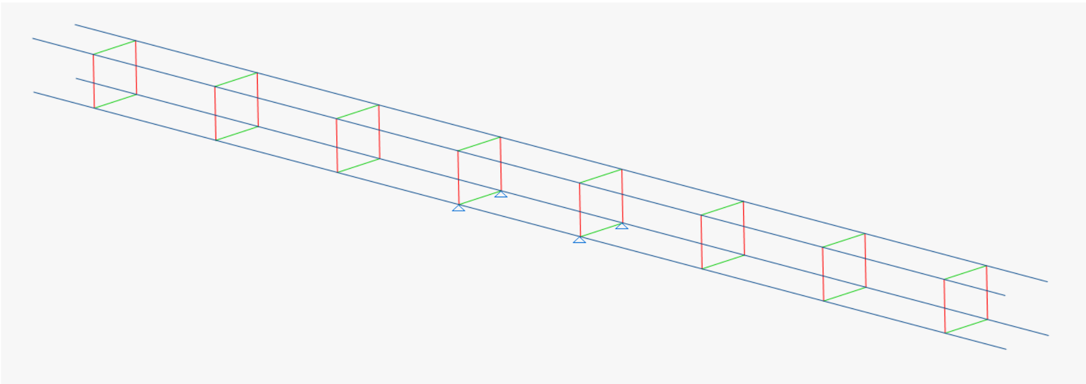


Load applied at 60° between lifting points on LB2.

Max Vertical Load =	350.00	kg
=	3.50	kN
2No Lifting Points =	1.75	kN
θ =	60	°
Horizontal Load =	1.75sin(60)	
=	1.52	kN
Vertical Load =	1.75cos(60)	
=	0.88	kN

STRAP Loading

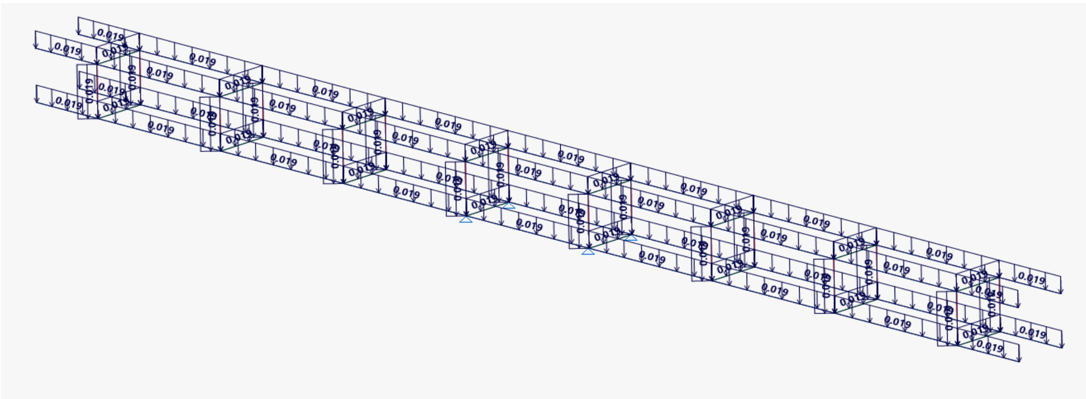
The ladder box beam was modelled using STRAP analysis package.



Load Cases Below are the forces applied for each load case:

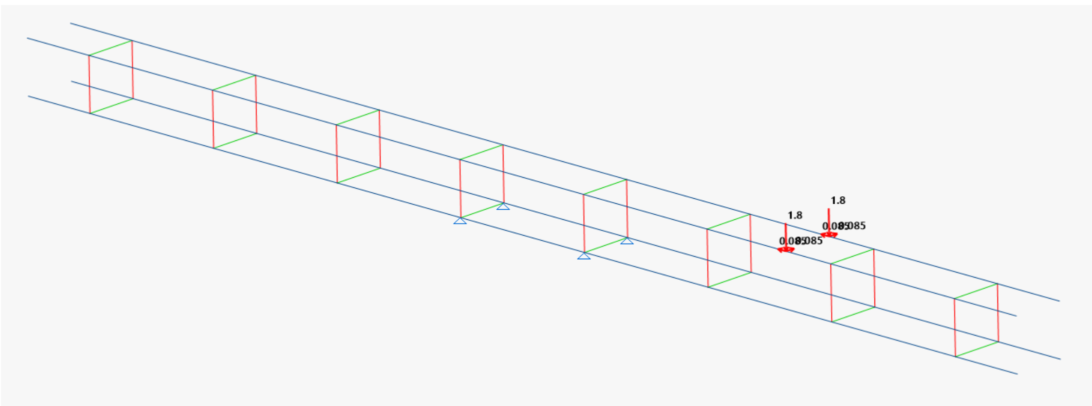
Load Case 1: **Self Weight**

Self weight of all members factored by 1.15 to allow for connections.

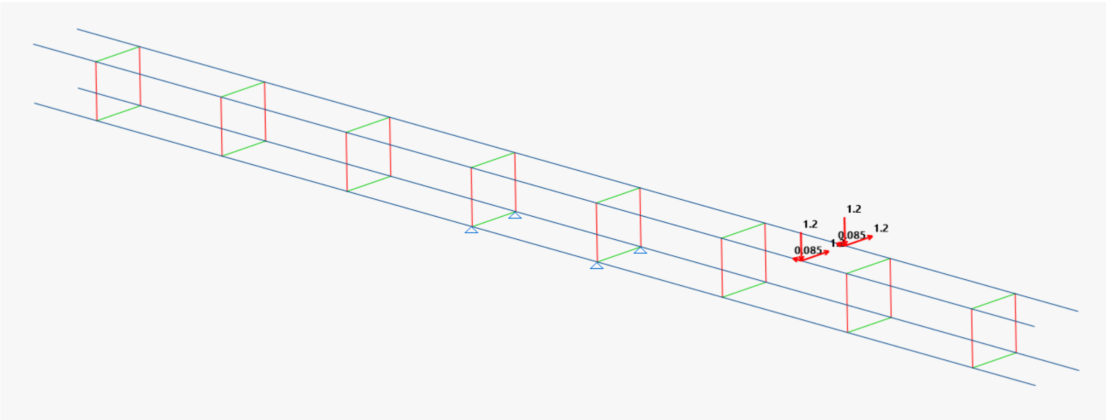


Load Case 2: **Loading Scenario 1**

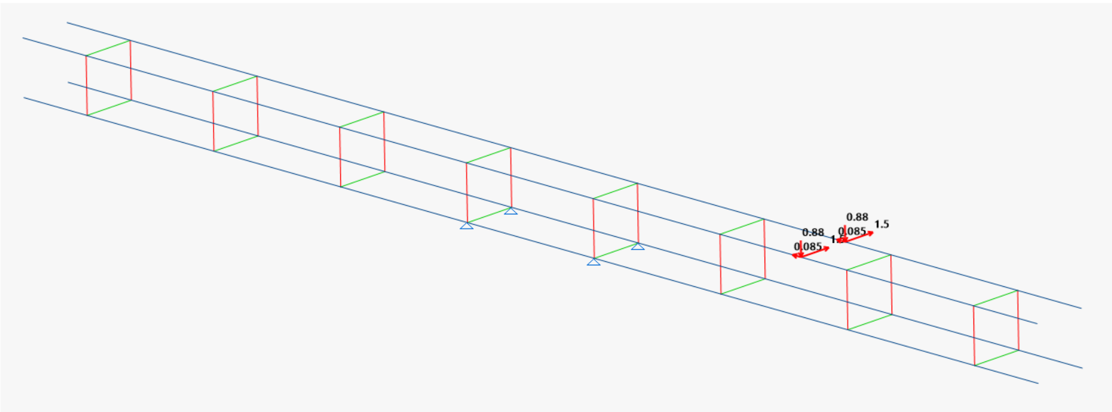
Loading Scenario 1 applied to beam 500mm from restraints.



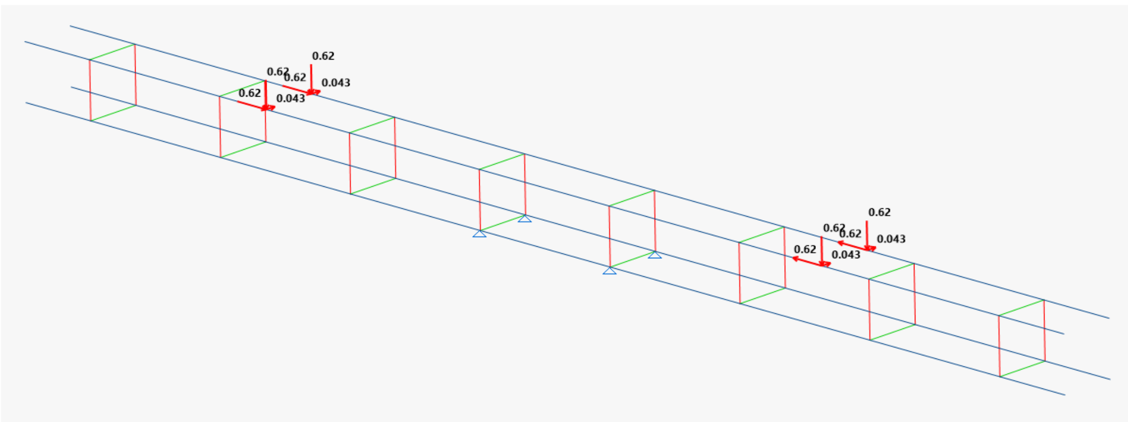
Load Case 3: **Loading Scenario 2**
Loading Scenario 2 applied to beam 500mm from restraints.



Load Case 4: **Loading Scenario 3**
Loading Scenario 3 applied to beam 500mm from restraints.

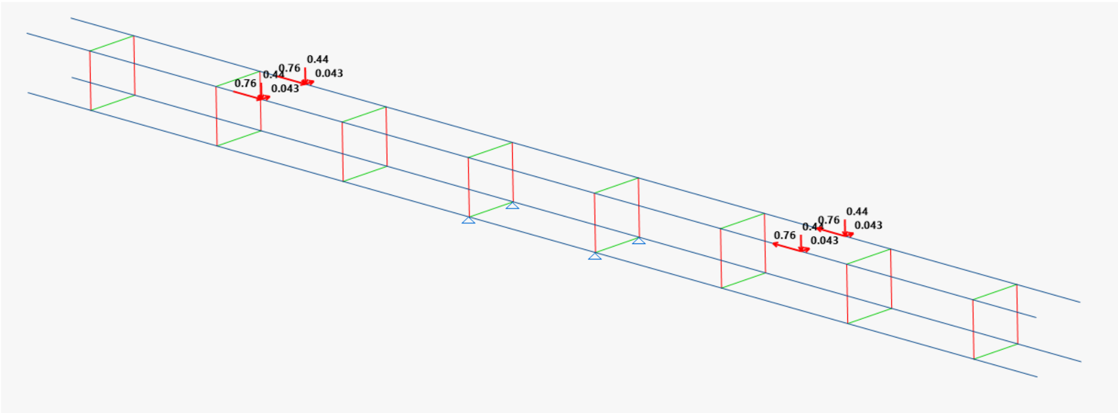


Load Case 5: **Loading Scenario 4**
Loading Scenario 4 applied to beam 500mm from restraints.



Load Case 6: **Loading Scenario 5**

Loading Scenario 5 applied to beam 500mm from restraints.



Load Combinations

	Combination	Load Cases
SLS 1	1	1+2
ULS 1	2	1+2
SLS 2	3	1+3
ULS 2	4	1+3
SLS 3	5	1+4
ULS 3	6	1+4
SLS 4	5	1+5
ULS 4	6	1+5
SLS 5	5	1+6
ULS 5	6	1+6

Above Combinations were checked for the following design factors

Serviceability Limit State, SLS

Dead Load Factor of Safety, γ_D= 1.00

Live Load Factor of Safety, γ_L= 1.00

Ultimate Limit State, ULS

BS EN 13155 states a factor of safety of 2 times the working load limit required. Apply 1.25 dynamic factor also:

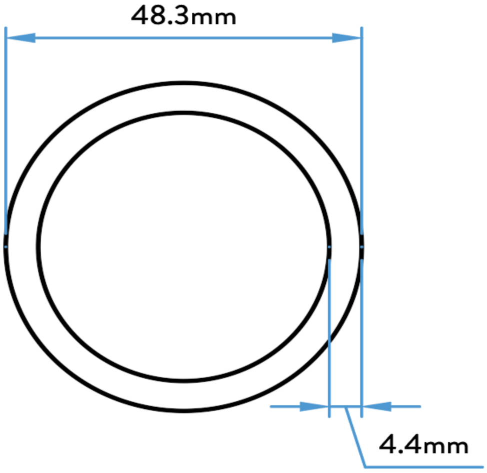
FOS = 2.00*1.25
= 2.50

Main Boom Capacity
ø48.3mm x 4.4mm - 6082-T6

Alu. 6082-T6

$P_{o,haz}$ = 0.50
$P_{u,haz}$ = 0.64
f_o = 255 N/mm^2
f_u = 295 N/mm^2

Class A Material



A= 607 mm^2
L = 305 mm
k = 1.00
L_{cr} = 305 mm
I= 147654 mm^4
W_{el}= 6114 mm^3
W_{pl}= 8254 mm^3
r_y= 15.6 mm

for slenderness

β= b/t   b= 48.3 mm
= 10.98   t = 4.4 mm

ε= sqrt(250/f_o) f_o= 255 N/mm^2
= 0.99

Class A, without welds, Internal parts

β_1= 11ε
= 11*1.00
= 11.00
> 10.98

Section is class 1

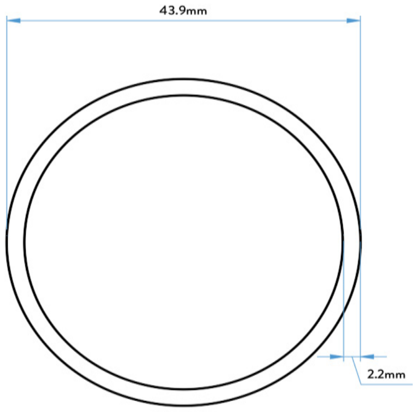
HAZ Length

Part perimeter weld at the joint, therefore part section is affected by HAZ.

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

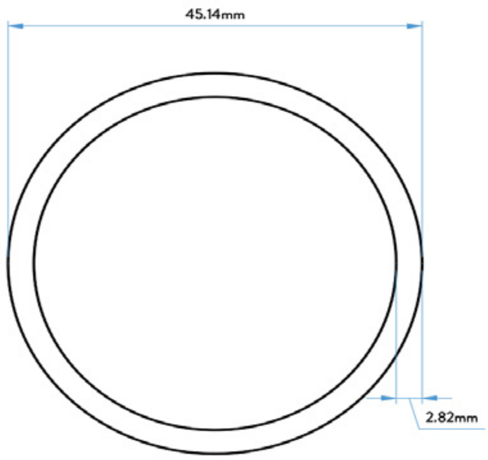
As per BS EN 1999-1-1, for HAZ wall thickness factored by 0.64 (For $P_{u,haz}$)

Po,haz HAZ Section Layout



A_{haz}=	288	mm^2
I=	62820	mm^4
W_{el}=	2862	mm^3
W_{pl}=	3864	mm^3

Pu,haz HAZ Section Layout



A_{haz}=	375	mm^2
I=	84308	mm^4
W_{el}=	3,735	mm^3
W_{pl}=	5,043	mm^3

Moment Capacity (6.2.5.1)

Non-HAZ

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

$\alpha = W_{pl}/W_{el}$ (Table 6.4)

$= 1.35$

$W_{el} = 6.11\ cm^3$

$f_o = 255\ N/mm^2$

$\gamma_{M1} = 1.1$ (6.1.3)

= 1.35*6.11*255/1100

$M_{c,Rd} = 1.91$ kNm

HAZ

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

$W_{net} = W_{u\ eff}$

$= 3.74\ cm^3$

$f_u = 295\ N/mm^2$

$\gamma_{M2} = 1.25$ (6.1.3)

= 3.74*295/1250

$M_{u,Rd} = 0.88$ kNm

$M_{Rd,x} = 0.88$ kNm — lesser value of $M_{c,Rd} / M_{u,Rd}$

Shear Capacity (6.2.6)

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

Conservatively

$A_v = nA_e$

$n = 0.60$

$A_e = 288\ mm^2$

$A_v = 0.6*288$

$A_v = 172.80\ mm^2$

$f_o = 255\ N/mm^2$

$\gamma_{M1} = 1.1$

= 172.80*255/(SQRT(3)*1100)

$V_{Rd} = 23.13$ kN

Vertical 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

$I =$ 147,654 mm^4

$L_{cr} =$ 305.00 mm

$N_{cr} =$ (((PI()^2)*70000*147654))/((305^2))

= 1,096,587.58 N

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

= 0.38 $A_{eff} =$ 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

$\Phi =$ 0.60

$X =$ 0.94

$k =$ 1.00 (no welds)

$N_{b,Rd} =$ 1.00*0.94*607*250/1100

= 132.27 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 = 147,654 mm^4
L_{cr} = 305.00 mm

N_{cr} = (((PI()^2)*70000*147654))/((305^2))
= 1,096,587.58 N

$\lambda_{haz} = \sqrt{A_{u,eff} f_u / N_{cr}}$ (6.3.1.2)
= 0.28

$A_{u,eff}$ = 375 mm^2

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

$\Phi = 0.5(1+ά(\lambda-\lambda_o)+\lambda^2)$
ά = 0.20 Table 6.6
λ_o= 0.10 Table 6.6
Φ = 0.56

X_{haz} = 0.96

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

For end results
$x_{s,haz}$ = 150 mm

= 1.00

$N_{b,Rd}$ = 0.96*1.00*375*295/1250
= 85.24 kN

Lesser Value= 85.24 kN

Axial Tension Capacity (6.2.3)

1. General yielding

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

f_o = 255 N/mm^2

A_g = A

= 607 mm^2

γ_{M1} = 1.1

= 607*255/1100

= 140.67 kN

2. Local failure

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

f_u = 295 N/mm^2

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

γ_{M1} = 1.25

= 288*295/1250

= 67.97 kN

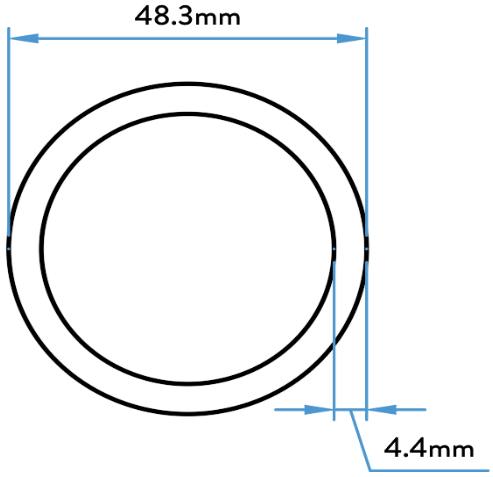
Lesser Value= 67.97 kN

Vertical and Horizontal Boom Capacity

ø48.3mm x 4.4mm - 6082-T6

Alu. 6082-T6	$P_{o,haz}$ =	0.50	
	$P_{u,haz}$ =	0.64	
	f_o =	255	N/mm^2
	f_u =	295	N/mm^2

Class A Material



A=	607	mm^2
L =	160	mm
k =	0.70	
L_{cr} =	112	mm
I=	147654	mm^4
W_{el}=	6114	mm^3
W_{pl}=	8254	mm^3
r_y=	15.6	mm

for slenderness	β=	b/t	b=	48.3 mm
	=	10.98	t =	4.4 mm
	ε=	sqrt(250/f_o)	f_o=	255 N/mm^2
	=	0.99		

Class A, without welds, Internal parts	β_1=	11ε
	=	11*1.00
	=	11.00
	>	10.98

Section is class 1

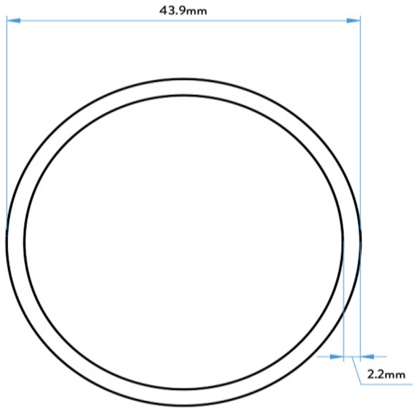
HAZ Length

Part perimeter weld at the joint, therefore part section is affected by HAZ.

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

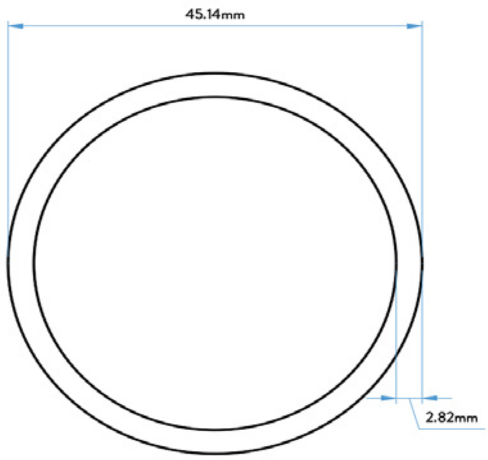
As per BS EN 1999-1-1, for HAZ wall thickness factored by 0.64 (For $P_{u,haz}$)

Po,haz HAZ Section Layout



A_{haz}=	288 mm^2
I=	62820 mm^4
W_{el}=	2862 mm^3
W_{pl}=	3864 mm^3

Pu,haz HAZ Section Layout



A_{haz}=	375 mm^2
I=	84308 mm^4
W_{el}=	3,735 mm^3
W_{pl}=	5,043 mm^3

Moment Capacity (6.2.5.1)

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

$\alpha = W_{pl}/W_{el}$ (Table 6.4)
= 1.35
$W_{el} =$ 6.11 cm^3
$f_o =$ 255 N/mm^2
$\gamma_{M1} =$ 1.1 (6.1.3)

= 1.35*6.11*255/1100
$M_{c,Rd} =$ 1.91 kNm

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

$W_{net} = W_{u\ eff}$
= 3.74 cm^3
$f_u =$ 295 N/mm^2
$\gamma_{M2} =$ 1.25 (6.1.3)

= 3.74*295/1250
$M_{u,Rd} =$ 0.88 kNm

$M_{Rd,x} =$ 0.88 kNm lesser value of $M_{c,Rd}$ / $M_{u,Rd}$

Shear Capacity (6.2.6)

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

$A_v = nA_e$
n = 0.60
$A_e =$ 288 mm^2
$A_v =$ 0.6*288
$A_v =$ 172.80 mm^2
$f_o =$ 255 N/mm^2
$\gamma_{M1} =$ 1.1

= 172.80*255/(SQRT(3)*1100)
$V_{Rd} =$ 23.13 kN

Vertical 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
$I =$ 147,654 mm^4
$L_{cr} =$ 112.00 mm

N_{cr} = (((PI()^2)*70000*147654))/((213.50^2))
= 8,132,179.51 N

$\lambda = \sqrt{A_{eff} f_o / N_{cr}}$ (6.3.1.2)
= 0.14 $A_{eff} =$ 607 mm^2

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

$\Phi = 0.5(1+\alpha(\lambda-\lambda_o)+\lambda^2)$
$\alpha =$ 0.20 Table 6.6
$\lambda_o =$ 0.10 Table 6.6
$\Phi =$ 0.51

X = 0.99

k= 1.00 (no welds)

$N_{b,Rd}$ = 1.00*0.58*607*250/1100
= 139.59 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 = 147,654 mm^4

L_{cr} = 112.00 mm

N_{cr} = (((PI()^2)*70000*147654))/((11.2^2))

= 8,132,179.51 N

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

= 0.11

$A_{u,eff}$ = 375 mm^2

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

$\Phi = 0.5(1+ά(\lambda-\lambda_o)+\lambda^2)$

ά = 0.20 Table 6.6

λ_o = 0.10 Table 6.6

Φ = 0.51

X_{haz} = 1.00

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

For end results

$x_{s,haz}$ = 0

= 1.00

$N_{b,Rd}$ = 1.00*1.00*375*295/1250

= 88.50 kN

Lesser Value= 88.50 kN

Axial Tension Capacity (6.2.3)

1. General yielding

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

$f_o =$ 255 N/mm^2

$A_g =$ A

$=$ 607 mm^2

$\gamma_{M1} =$ 1.1

= 607*255/1100

= 140.67 kN

2. Local failure

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

$f_u =$ 295 N/mm^2

$A_{u,eff} =$ 375 mm^2

$\gamma_{M1} =$ 1.25

= 375*295/1250

= 88.50 kN

Lesser Value= 88.50 kN

ULS Results

Load Combination 2 - ULS 1

	Action	Formula	Ultimate	Calculated	Factor
Main Boom					
	Moment - x	$M_{Rd,x}$	0.88	0.61	0.69
	Moment - y	$M_{Rd,y}$	0.88	0.02	0.02
	Shear	V_{Rd}	23.13	3.61	0.16
	Tension	$N_{u,Rd}$	67.97	11.69	0.17
	Compression	$N_{b,Rd}$	85.24	12.32	0.14
	Combined	<1.0	1.00	0.77	0.77
Verticals					
	Moment - x	$M_{Rd,x}$	0.88	0.51	0.58
	Moment - y	$M_{Rd,y}$	0.88	0.01	0.01
	Shear	V_{Rd}	23.13	8.58	0.37
	Tension	$N_{u,Rd}$	67.97	3.45	0.05
	Compression	$N_{b,Rd}$	88.50	5.83	0.07
	Combined	<1.0	1.00	0.60	0.60
Horizontals					
	Moment - x	$M_{Rd,x}$	0.88	0.01	0.01
	Moment - y	$M_{Rd,y}$	0.88	0.03	0.03
	Shear	V_{Rd}	23.13	0.45	0.02
	Tension	$N_{u,Rd}$	67.97	0.00	0.00
	Compression	$N_{b,Rd}$	88.50	0.00	0.00
	Combined	<1.0	1.00	0.03	0.03

Load Combination 4 - ULS 2

	Action	Formula	Ultimate	Calculated	Factor
Main Boom					
	Moment - x	$M_{Rd,x}$	0.88	0.45	0.51
	Moment - y	$M_{Rd,y}$	0.88	0.30	0.34
	Shear	V_{Rd}	23.13	2.68	0.12
	Tension	$N_{u,Rd}$	67.97	13.44	0.20
	Compression	$N_{b,Rd}$	85.24	19.74	0.23
	Combined	<1.0	1.00	0.79	0.79
Verticals					
	Moment - x	$M_{Rd,x}$	0.88	0.46	0.52
	Moment - y	$M_{Rd,y}$	0.88	0.13	0.15
	Shear	V_{Rd}	23.13	7.77	0.34
	Tension	$N_{u,Rd}$	67.97	2.51	0.04
	Compression	$N_{b,Rd}$	88.50	7.01	0.08
	Combined	<1.0	1.00	0.58	0.58
Horizontals					
	Moment - x	$M_{Rd,x}$	0.88	0.17	0.19
	Moment - y	$M_{Rd,y}$	0.88	0.36	0.41
	Shear	V_{Rd}	23.13	6.51	0.28
	Tension	$N_{u,Rd}$	67.97	0.00	0.00
	Compression	$N_{b,Rd}$	88.50	0.00	0.00
	Combined	<1.0	1.00	0.47	0.47

Load Combination 6 - ULS 3

	Action	Formula	Ultimate	Calculated	Factor
Main Boom					
	Moment - x	$M_{Rd,x}$	0.88	0.36	0.41
	Moment - y	$M_{Rd,y}$	0.88	0.37	0.42
	Shear	V_{Rd}	23.13	2.66	0.12
	Tension	$N_{u,Rd}$	67.97	12.35	0.18
	Compression	$N_{b,Rd}$	85.24	20.03	0.23
	Combined	<1.0	1.00	0.77	0.77
Verticals					
	Moment - x	$M_{Rd,x}$	0.88	0.38	0.43
	Moment - y	$M_{Rd,y}$	0.88	0.16	0.18
	Shear	V_{Rd}	23.13	6.46	0.28
	Tension	$N_{u,Rd}$	67.97	1.81	0.03
	Compression	$N_{b,Rd}$	88.50	6.55	0.07
	Combined	<1.0	1.00	0.51	0.51
Horizontals					
	Moment - x	$M_{Rd,x}$	0.88	0.20	0.23
	Moment - y	$M_{Rd,y}$	0.88	0.45	0.51
	Shear	V_{Rd}	23.13	7.98	0.35
	Tension	$N_{u,Rd}$	67.97	0.00	0.00
	Compression	$N_{b,Rd}$	88.50	0.00	0.00
	Combined	<1.0	1.00	0.58	0.58

Load Combination 8 - ULS 4

	Action	Formula	Ultimate	Calculated	Factor
Main Boom					
	Moment - x	$M_{Rd,x}$	0.88	0.16	0.18
	Moment - y	$M_{Rd,y}$	0.88	0.01	0.01
	Shear	V_{Rd}	23.13	1.06	0.05
	Tension	$N_{u,Rd}$	67.97	5.33	0.08
	Compression	$N_{b,Rd}$	85.24	4.93	0.06
	Combined	<1.0	1.00	0.20	0.20
Verticals					
	Moment - x	$M_{Rd,x}$	0.88	0.20	0.23
	Moment - y	$M_{Rd,y}$	0.88	0.00	0.00
	Shear	V_{Rd}	23.13	3.41	0.15
	Tension	$N_{u,Rd}$	67.97	0.04	0.00
	Compression	$N_{b,Rd}$	88.50	0.89	0.01
	Combined	<1.0	1.00	0.23	0.23
Horizontals					
	Moment - x	$M_{Rd,x}$	0.88	0.01	0.01
	Moment - y	$M_{Rd,y}$	0.88	0.01	0.02
	Shear	V_{Rd}	23.13	0.25	0.01
	Tension	$N_{u,Rd}$	67.97	0.00	0.00
	Compression	$N_{b,Rd}$	88.50	0.00	0.00
	Combined	<1.0	1.00	0.02	0.02

Load Combination 10 - ULS 5

	Action	Formula	Ultimate	Calculated	Factor
Main Boom					
	Moment - x	$M_{Rd,x}$	0.88	0.11	0.13
	Moment - y	$M_{Rd,y}$	0.88	0.01	0.01
	Shear	V_{Rd}	23.13	0.76	0.03
	Tension	$N_{u,Rd}$	67.97	3.19	0.05
	Compression	$N_{b,Rd}$	85.24	3.70	0.04
	Combined	<1.0	1.00	0.14	0.14
Verticals					
	Moment - x	$M_{Rd,x}$	0.88	0.15	0.17
	Moment - y	$M_{Rd,y}$	0.88	0.00	0.00
	Shear	V_{Rd}	23.13	2.48	0.11
	Tension	$N_{u,Rd}$	67.97	0.03	0.00
	Compression	$N_{b,Rd}$	88.50	0.67	0.01
	Combined	<1.0	1.00	0.16	0.16
Horizontals					
	Moment - x	$M_{Rd,x}$	0.88	0.01	0.01
	Moment - y	$M_{Rd,y}$	0.88	0.01	0.02
	Shear	V_{Rd}	23.13	0.25	0.01
	Tension	$N_{u,Rd}$	67.97	0.00	0.00
	Compression	$N_{b,Rd}$	88.50	0.00	0.00
	Combined	<1.0	1.00	0.02	0.02

Combined Section Compression Check

Check the beam as a combined section for the maxmium compression load in the beam.

Max Compression = 20.03 kN (Factored)

Box Beam Capacity

ø48.3mm x 4.4mm -

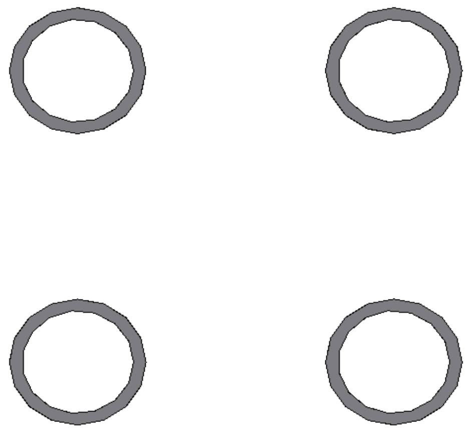
Alu. 6082-T6

$P_{o,haz}$ = 0.50

$P_{u,haz}$ = 0.64

f_o = 250 N/mm^2

f_u = 290 N/mm^2



A=	2427 mm^2
L =	1000 mm
k =	2.00
L_{cr} =	2000 mm
I_x=	8171462 mm^4
I_y=	8171462 mm^4
$W_{el,x}$=	102099 mm^3
$W_{pl,x}$=	137833 mm^3
$W_{el,y}$=	102099 mm^3
$W_{pl,y}$=	137833 mm^3

for slenderness

	β=	b/t	b=	48.3 mm
	=	10.98	t =	4.4 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
	>	10.98

Section is class 1

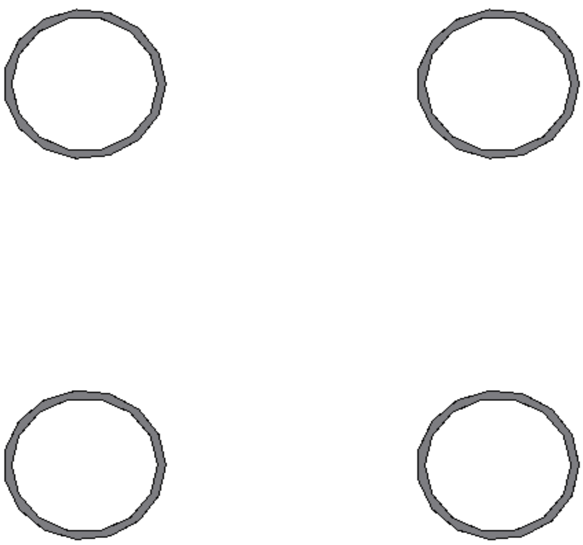
HAZ Length

Part perimeter weld at the joint, therefore part section is affected by HAZ.

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

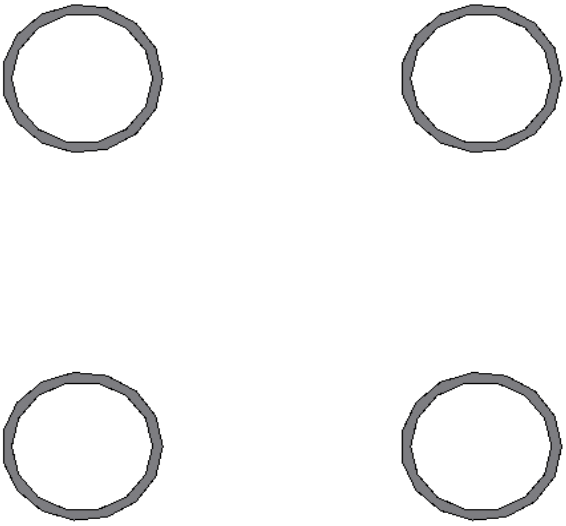
As per BS EN 1999-1-1, for HAZ wall thickness factored by 0.64 (For $P_{u,haz}$)

Po,haz HAZ Section Layout



A_{haz}=	1153	mm^2
I_x=	3851749	mm^4
I_y=	3851749	mm^4
$W_{el,x}$=	49483	mm^3
$W_{pl,x}$=	66802	mm^3
$W_{el,y}$=	49483	mm^3
$W_{pl,y}$=	66802	mm^3

Pu,haz HAZ Section Layout



A_{haz}=	1500 mm^2
I_x=	5020998 mm^4
I_y=	5020998 mm^4
$W_{el,x}$=	63994 mm^3
$W_{pl,x}$=	86392 mm^3
$W_{el,y}$=	63994 mm^3
$W_{pl,y}$=	86392 mm^3

Vertical 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
$I =$ 8,171,462 mm^4
$L_{cr} =$ 2,000.00 mm

$N_{cr} =$ (((PI()^2)*70000*8171462))/((2000^2))
= 1,411,359 N

$\lambda = \sqrt{A_{eff} f_o / N_{cr}}$ (6.3.1.2)
= 0.66 $A_{eff} =$ 2427 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
$\Phi =$ 0.77

$X =$ 0.85

$k =$ 1.00 (no welds)

$N_{b,Rd} =$ 1.00*0.85*607*250/1100
= 469.40 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

$I =$ 8,171,462 mm^4

$L_{cr} =$ 2,000.00 mm

N_{cr} = (((PI()^2)*70000*8171462))/((2000^2))

= 1,411,359.20 N

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

= 0.48

$A_{u,eff} =$ 1500 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

$\Phi =$ 0.66

$X_{haz} =$ 0.91

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

For end results

$x_{s,haz} =$ 100 mm

= 1.08

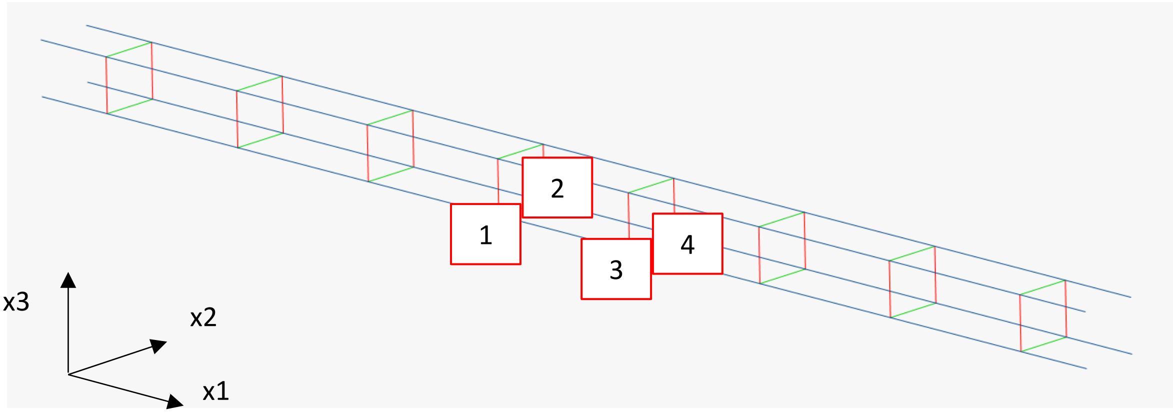
$N_{b,Rd}$ = 0.91*1.08*1500*0/1250

= 295.44 kN

Lesser Value= 295.44 kN

\> 20.03 kN **OK**

SLS Reactions



Note: All values below are in kN.

Load Combination 1 - SLS 1

	x1	x2	x3
1	-3.76	0.03	-2.77
2	-3.61	0.03	-2.78
3	3.27	-0.12	4.47
4	4.27	-0.12	4.83

Load Combination 3 - SLS 2

	x1	x2	x3
1	-3.77	0.48	-1.82
2	-1.55	0.48	-2.04
3	-4.59	-1.71	0.71
4	10.07	-1.71	5.87

Load Combination 5 - SLS 3

	x1	x2	x3
1	-3.30	0.58	-1.20
2	-0.58	0.58	-1.48
3	-6.97	-2.10	-0.83
4	11.02	-2.10	5.51

Load Combination 7 - SLS 4

	x1	x2	x3
1	-2.52	-0.04	0.60
2	-2.95	-0.04	0.77
3	2.52	-0.04	0.60
4	2.95	-0.04	0.77

Load Combination 9 - SLS 5

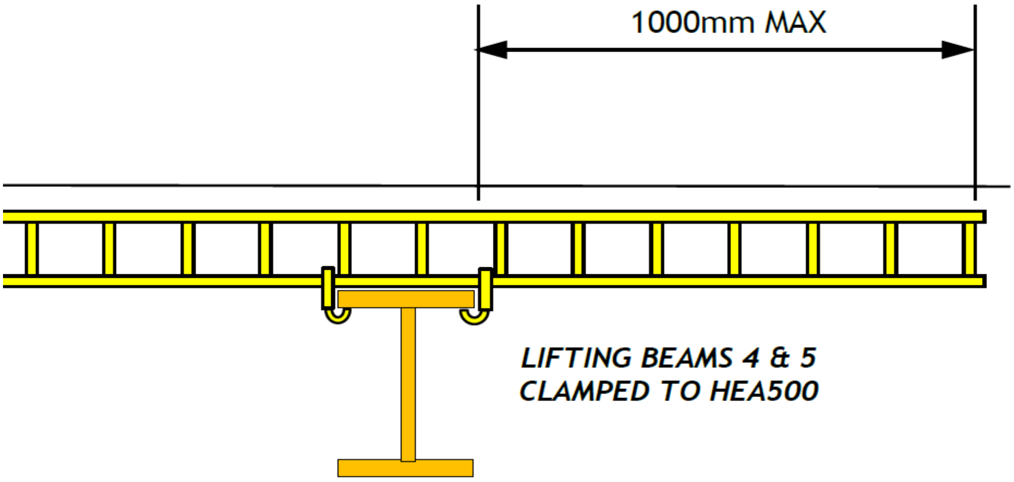
	x1	x2	x3
1	-1.80	-0.04	0.42
2	-2.23	-0.04	0.59
3	1.80	-0.04	0.42
4	2.23	-0.04	0.59

Deflections

Max Differential Deflection = 7.81 mm

Allowable Deflection = L/100
= 1000/100
= 10.00 mm
> 7.81 mm **OK**

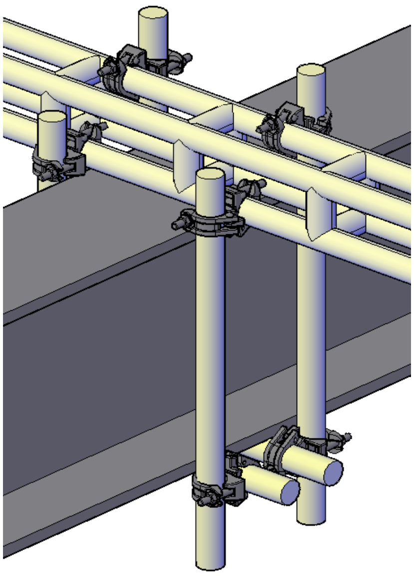
Fixing Check



Max Reaction =	11.02 kN	
Pair of Gravlock SWL =	6.00 kN	
<	11.02 kN	**FAILS**

GRAVLOCK FIXINGS FAILS DESIGN CHECKS.

Box Tie Check



Double box ties must be installed to fix ladder box beam to existing.

Max Downforce =	5.87 kN		
Class A Coupler Capacity =	6.10 kN		
>	5.87 kN	**OK**	
Scaffold Tube Axial Capacity =	79.30 kN		(TG20:13 Table C.2 L=600mm)
>	5.87 kN	**OK**	
Bottom Tube Moment =	5.87*0.35/4		
=	0.51 kNm		
Scaffold Tube Moment Capacity =	1.33 kNm		(TG20:13 Table C.1)
>	0.51 kNm	**OK**	
Max X1 Reaction =	11.02 kN		
Max X2 Reaction =	2.10 kN		
Resultant Horizontal =	11.22 kN		
Scaffold Tube Shear Capacity =	35.26 kN		
>	11.22 kN	**OK**	

Client: Apollo Scaffold Services Ltd

Project: 160mm Ladder Box Beam **Job No:** 22207-02 **By:** pl

Element: Designers Risk Assessment **Doc No:** 001A **Checked:** es **Date:** Thursday Oct 20, 2022

ALANWHITEDESIGN

Impact:	Probability:
1: Nil or slight injury / illness, property damage or environmental issue.	1 - Highly Unlikely
2: Minor injury / illness, property damage or environmental issue.	2 - Unlikely
3: Moderate injury or illness, property damage or environmental issue.	3 - Possible
4: Major injury or illness, property damage or environmental issue.	4 - Likely
5: Fatal or long term disabling injury or illness, property damage or environmental issue.	5 - Highly Likely

Risk type:	
Design	D
Construction	C
Operational	O
Decomissioning	D
-	-

Risk Rating
Risk Rating System:
Where the rating is 5 or less, no further action is required.
Where the rating is 6 or more, the risk is unacceptable and control measures are required.

Risk

LIKELIHOOD					
5	5	10	15	20	25
4	4	8	12	16	20
3	3	6	9	12	15
2	2	4	6	8	10
1	1	2	3	4	5
	1	2	3	4	5

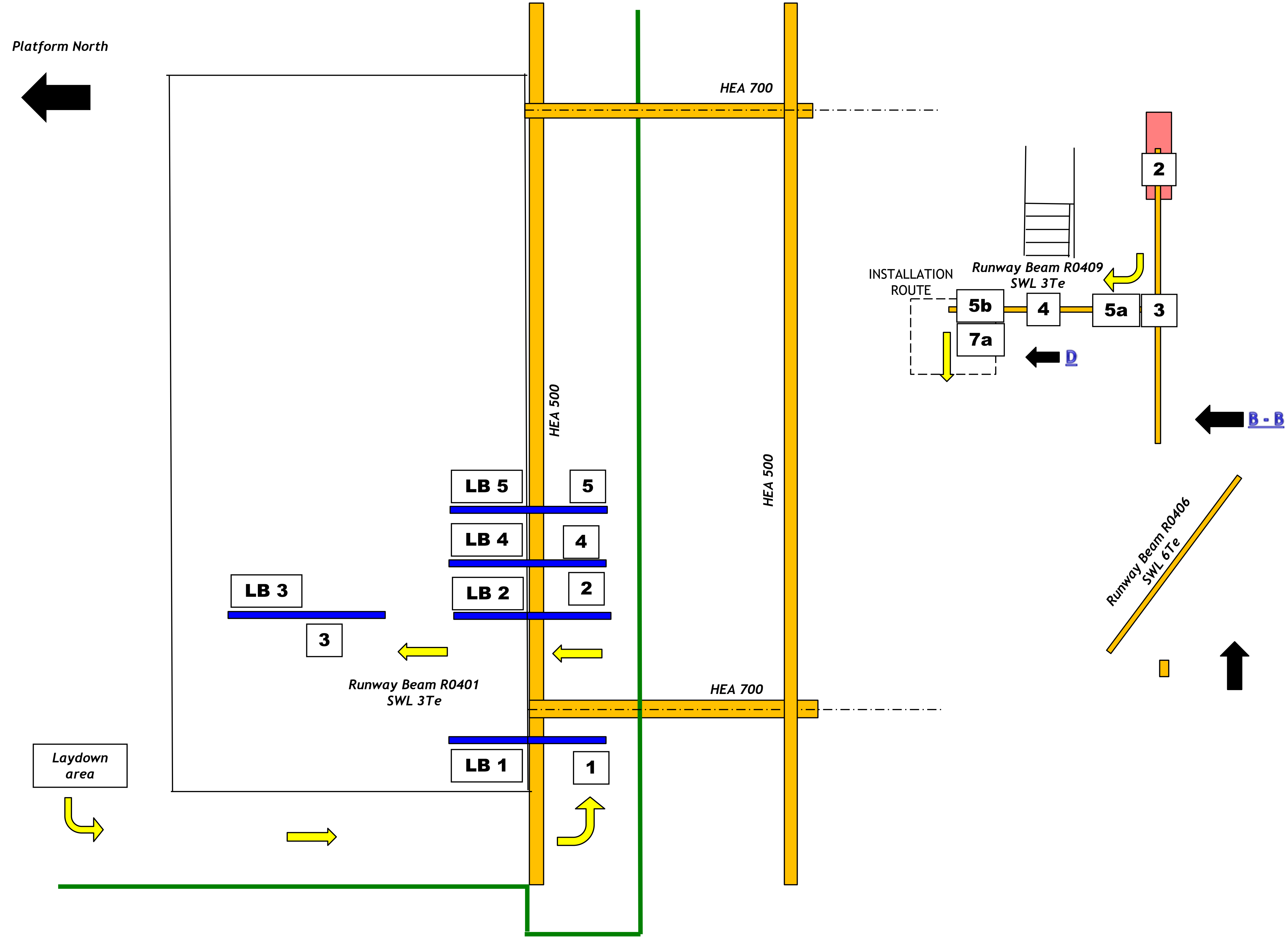
SEVERITY

Ref No	Risk Type	Activity / Element	Potential Hazard	Population at Risk	Prob	Imp	Risk Rating	Action at Design Stage	Prob	Imp	Risk Rating	Residual Risk	Residual Risk Description	Notes
1	D	Beam Failure	Failure of beam due to insufficient capacity.	operative_contractors	3	5	15	Beam has been checked for worst case loading with capacities derived from EN 1999-1-1.	1	5	5	N		Max lifting load is 350kg.
2	D	Existing Structure	Failure of existing structure due to imposed loading from box beam.	operative_contractors	3	5	15	Reactions from lifting beam have been included in this report.	3	5	15	Y	Client to ensure existing structure is assessed for imposed loadings prior to operation.	

APPENDIX A

CLIENT PROVIDED DRAWING

Lift Plan- 075721 - LP Sketch



PLAN VIEW ON SOUTH WEST CORNER OF
UTILITY MODULE WALKWAY

EL +32.000m

STORK
A Fluor Company

Notes:
1. SWIS confirmed max load is 350Kg.
2. Timber dunnage as supplied by platform.
3. Lift plan to be reviewed by platform LOLER Focal Point / LOLER competent person.
4. Lift plan sketches are indicative only.
5. Units indicated as contingency can be installed if required following initial work site visit by Stork Lift responsible person.

TASK.

Installation of 3No caisson liners through MOD 4 pump room

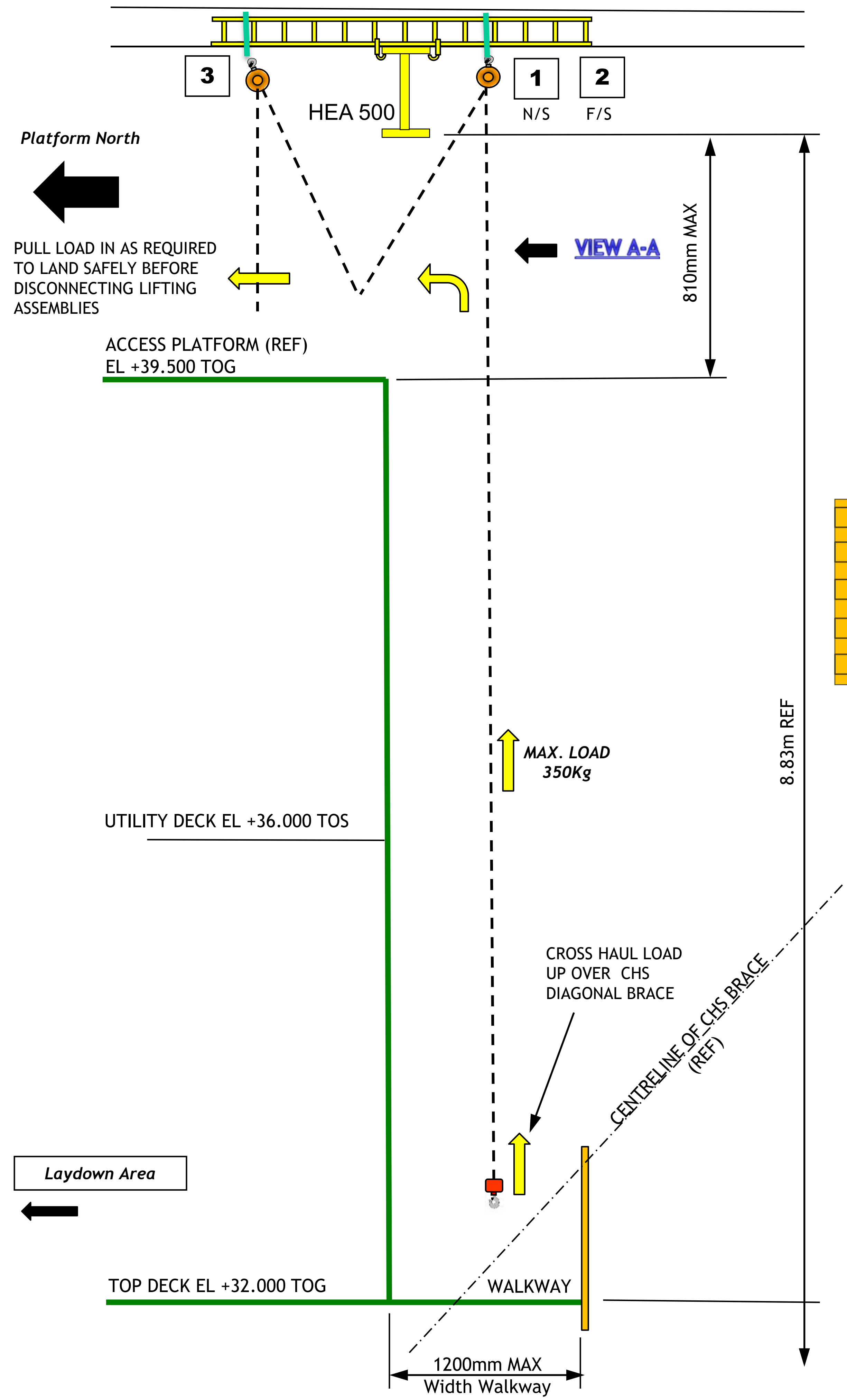
Stork supplied, certified rigging equipment to be used

CLIENT: Neptune (SWIS)	ISSUE: Rev 0
CONTRACTOR: STORK A Fluor Company	
PLANT: Utility Module	
LOCATION: iL5-FA Utility Module Upgrade	
TITLE: Louvre Removal & G21 Insulated Panel Installation	

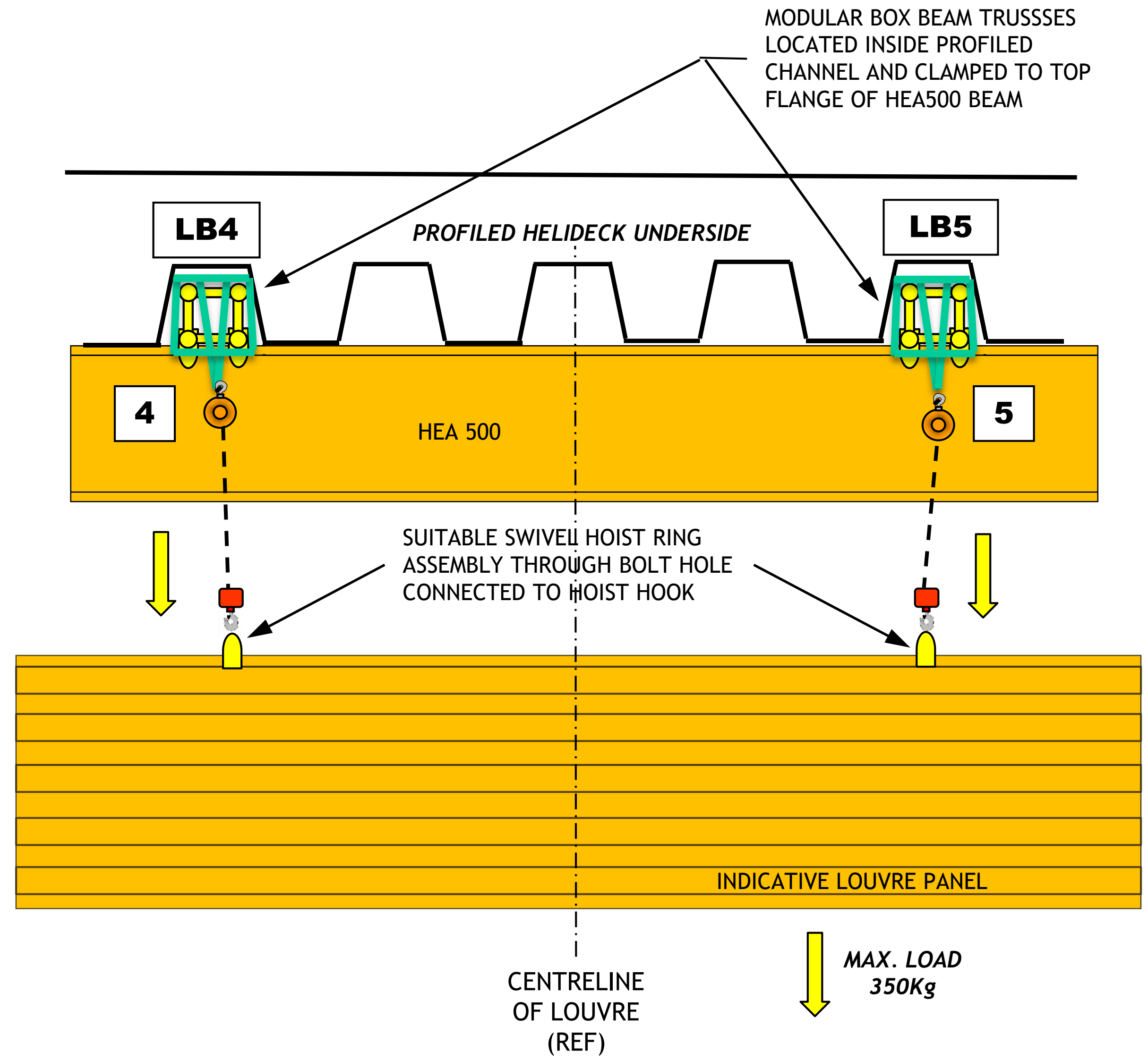
DRAWN:	DATE:	CHECKED:	DATE:
Gary M Donald	27.09.2022		

SCALE:	DRAWING No:	SHEET	REV.
N/A	075721 - Sketch 03	3	C0

Lift Plan- 075721 - LP Sketch

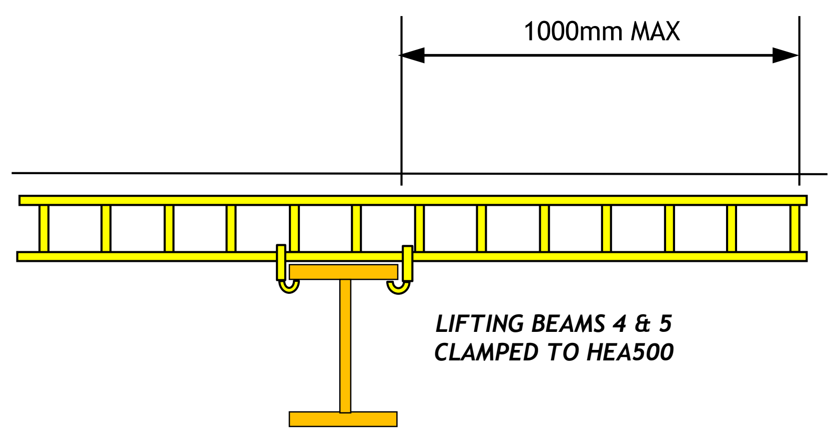


View Looking East



VIEW A-A

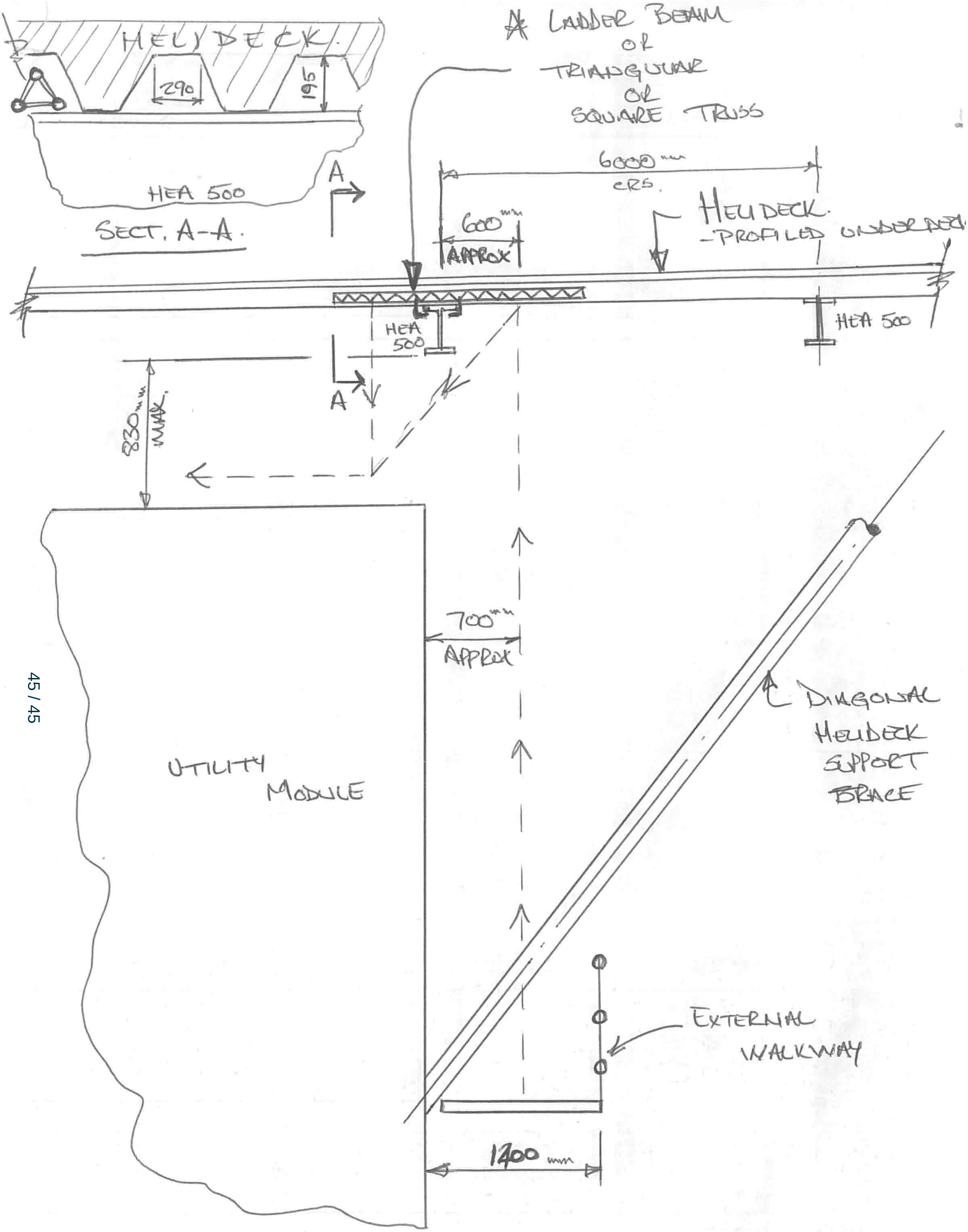
View looking North



SECTION B-B

Notes:
1. Lift Plan to be read in conjunction with Stork Installation methodology.
2. Handrails omitted for clarity.
3. Lift plan sketches are indicative only.

CLIENT: Neptune (SWIS)		ISSUE: Rev 0	
CONTRACTOR: STORK A Fluor Company			
PLANT: Utility Module LOCATION: iL5-FA Utility Module Upgrade			
TITLE: Louvre Removal & G21 Insulated Panel Installation			
DRAWN: Gary M Donald	DATE: 27.09.2022	CHECKED:	DATE:
SCALE: N/A	DRAWING No: 075721 - Sketch 03	SHEET 3	REV. C0


HELIDECK
290
195
HEA 500
SECT. A-A.
A
LADDER BEAM
OR
TRIANGULAR
OR
SQUARE TRUSS
6000 mm
CRS.
600 mm
APPROX
HELIDECK
-PROFILED
HEA 500
HEA 500
830 mm MAX.
700 mm
APPROX
DIAGONAL
HELIDECK
SUPPORT
BRACE
UTILITY
MODULE
EXTERNAL
WALKWAY
1400 mm

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