A. A. Barnes & Coy. Pty. Ltd.

Consulting Engineers

41 Evans Court
Toorak, Vic 3142

ABN 16-004-919-340

Tel: 03 9822 5889
Fax: 03 9822 5542

TuffLift P/L
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7 Feb 12

Machinery description:

Vehicle Hoist

Mark machinery:

Plant model, TL4.0OHDI (9KOH)

Rated capacity, 4.00 t

Engineer's Certification:

This machinery has been designed in accordance with:

AS 1418.1 - 2002	Cranes code
AS 1418.9 - 1996	Vehicle hoists
AS 3990 - 1993	Mechanical Equipment - Steelwork
Occupational Health & Safety (Plant) Regulations 1995 Victoria.	

In my opinion the design adequately complies with the current codes & regulations as required by WorkSafe Victoria & is capable of safely & effectively carrying out the functions for which it was designed.

A copy of the calculations & drawings is attached.

Alex A.Barnes

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Tel: 03 9822 5889
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TuffLift P/L

7 Feb 12

Vehicle Hoist

Plant model = TL4.0OHDI (9KOH)

Lifts per day = 8

Days per year = 250 days

Crane life = 25 years Operating cycles = 50000

Utiliz/n class = U2

Load spectrum Kp = 0.50

State of loading = Q3

Crane group classification = C2

Dynamic factor, $\phi 1$ = 1.10

Hoist appl/n gp = 2

Hoist velocity, vh = 0.08 m/s $\phi 2$ = 1.21

Load combination factor, τc = 1.25 ϕH = 1.25

Lifted load = 4.00 t Design load = 49.05 kN

Risk coefficient, τn = 1.00

Design arms:

Arms, Fy = 345.00 MPa

Ratio per arm = 30.00 %

Per arm, Design load = 14.71 kN

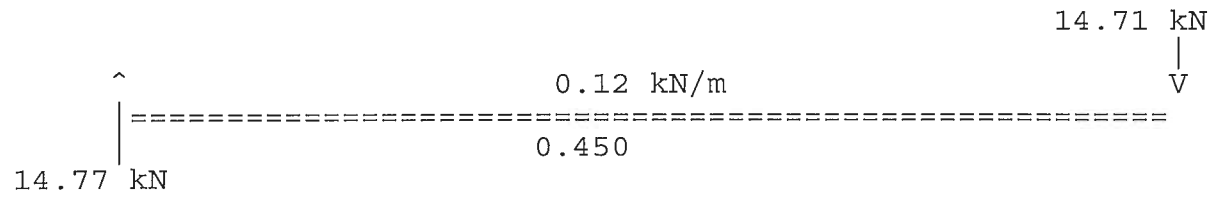
Case 1. Rear arms, 2 piece, bent:

Total radius = 1050.0 mm

Extension length = 575.0 mm

Extension radius = 450.0 mm

1. Extension: (2)



BM = 6.63 kNm

Beam Design to AS 3990

D = 60.0 mm

B = 80.0 mm

t = 6.0 mm

Corners, (Ri/t = 1.50

(Ri = 9.0 mm

(Ro = 15.0 mm

(Ac = 113 mm^2

(ey = 0.545

Fy = 345.00 MPa

Calculate properties about X--X axis:

	Area	1st mt about top	Y	A x Y^2	2nd mt	Ix
B2 flat	300	900	27.0	0.22	0.00	0.22
2 corners	226	1849	21.8	0.11	0.00	0.11
D2 flats	360	10800	0.0	0.00	0.03	0.03
2 corners	226	11723	21.8	0.11	0.00	0.11
B2 flat	300	17100	27.0	0.22	0.00	0.22
	1412	42372				0.682

Ytop = 30.0 mm

Ybot = 30.0 mm

Zx = 22.72 x10^3mm^3

rx = 22.0 mm

A = 1412 mm^2

Mass = 11.09 kg/m

Calculate properties about Y--Y axis:

	Area	Moment about LHS	Y	A x Y^2	2nd mt	Iy
D2 flat	180	540	37.0	0.25	0.001	0.25
2 corners	226	1849	31.8	0.23	0.000	0.23
B2 flats	600	24000	-0.0	0.00	0.125	0.13
2 corners	226	16246	31.8	0.23	0.000	0.23
D2 flat	180	13860	37	0.25	0.001	0.25
	1412	56496				1.08

Yl = 40.0 mm

Yr = 40.0 mm

Zy = 26.93 x10^3mm^3

ry = 27.6 mm

Maximum allowable BENDING stress:

Clause 5.2, Fb = 227.70 MPa

Maximum allowable compressive stress:

Maximum of, Fbc = Fy x 0.60

Fbc = 207.00 MPa

*** OR ***

Formula 5.3(4), Fbc = (0.72-0.12/635*b2/T1*Fy^.5)*Fy

Fbc = 238.31 MPa

Maximum, Fbc = 238.31 MPa

Calculate bending stress:

BM = 6.63 kNm

Clause 5.2 governs, *** Fbc = 227.70 MPa

*** fc = 291.95 MPa

*** Arm overstressed ***

Calculate maximum radius: Maximum, BM = 5.17 kNm

P = 14.71 kN

Maximum, r = 351.6 mm

Add top & bottom reinforcement: (4)

b = 50.0 mm

t = 3.0 mm

Ixw = 0.30 x10^6mm^4

Plus, IxSHS = 0.68 x10^6mm^4

Total, Ix = 0.98 x10^6mm^4

Zx = 31.10 x10^3mm^3

BM = 6.63 kNm

*** Fbc = 227.70 MPa

*** fc = 213.32 MPa

*** Arm O.K. in bending ***

Reinforcement length, L = 223.4 mm

Use, L = 250.0 mm

Maximum allowable SHEAR stress:

Effective area = 360.00 mm^2

d1/t = 5.00

V = 14.77 kN

*** Fv = 127.65 MPa

*** fv = 41.02 MPa

*** Beam O.K.in shear ***

Deflection as per AS 1418.9: Allowable deflection, span/300

Unfactored Pw + Phd = 2.94 kN

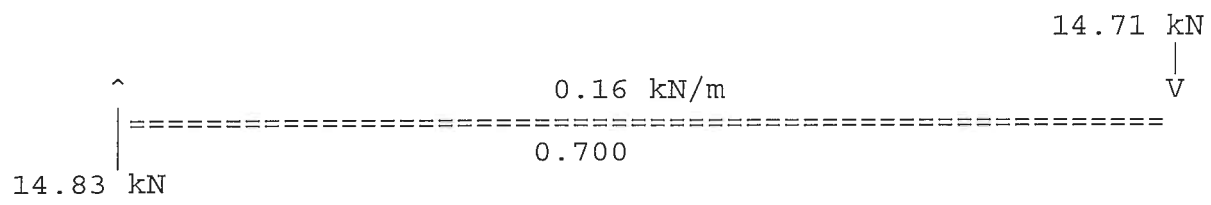
*** Allowable deflection, δ' = 1.5 mm

*** Calculated deflection, δ = 0.7 mm

*** Deflection O.K. ***

2. Main beam:

Effective radius = 700.0 mm



BM = 10.34 kNm

Beam Design to AS 3990

D	=	80.0 mm				
B	=	100.0 mm		d2	=	50.0 mm
t	=	6.0 mm		b2	=	70.0 mm
			Corners, (	Ri/t	=	1.50
			(	Ri	=	9.0 mm
			(	Ro	=	15.0 mm
			(	Ac	=	113 mm^2
			(	ey	=	0.545
				Fy	=	345.00 MPa

Calculate properties about X--X axis:

	Area	1st mt about top	Y	A x Y^2	2nd mt	Ix
B2 flat	420	1260	37.0	0.57	0.00	0.58
2 corners	226	1849	31.8	0.23	0.00	0.23
D2 flats	600	24000	0.0	0.00	0.13	0.13
2 corners	226	16246	31.8	0.23	0.00	0.23
B2 flat	420	32340	37.0	0.57	0.00	0.58
	1892	75696				1.74

Ytop	=	40.0	mm
Ybot	=	40.0	mm
Zx	=	43.39	x10^3mm^3
rx	=	30.3	mm
A	=	1892	mm^2
Mass	=	14.86	kg/m

Calculate properties about Y--Y axis:

	Area	Moment about LHS	Y	A x Y^2	2nd mt	Iy
D2 flat	300	900	47.0	0.66	0.001	0.66
2 corners	226	1849	41.8	0.40	0.000	0.40

B2 flats	840	42000	-0.0	0.00	0.343	0.34
2 corners	226	20770	41.8	0.40	0.000	0.40
D2 flat	300	29100	47	0.66	0.001	0.66
	1892	94619				2.46

Yl = 50.0 mm

Yr = 50.0 mm

Zy = 49.23 x10^3mm^3

ry = 36.1 mm

Maximum allowable BENDING stress:

Clause 5.2, Fb = 227.70 MPa

Maximum allowable compressive stress:

Maximum of, Fbc = Fy x 0.60

Fbc = 207.00 MPa

*** OR ***

Formula 5.3(4), Fbc = (0.72-0.12/635*b2/T1*Fy^.5)*Fy

Fbc = 234.27 MPa

Maximum, Fbc = 234.27 MPa

Calculate bending stress: BM = 10.34 kNm

Clause 5.2 governs, *** Fbc = 227.70 MPa

*** fc = 238.29 MPa

*** Arm satisfactory in bending ***

Maximum allowable SHEAR stress:

Effective area = 600.00 mm^2

d1/t = 8.33

V = 14.83 kN

*** Fv = 127.65 MPa

*** fv = 24.71 MPa

*** Beam O.K.in shear ***

Deflection as per AS 1418.9: Allowable deflection, span/300

Unfactored Pw + Phd = 2.94 kN

*** Allowable deflection, δ' = 2.3 mm

*** Calculated deflection, δ = 1.0 mm

*** Deflection O.K. ***

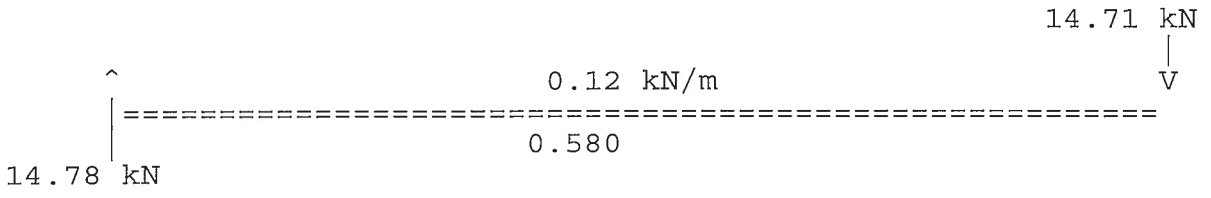
Case 2. Front arms, 2 piece:

Maximum radius = 1462.0 mm

Extension length = 806.0 mm

Extension radius = 580.0 mm

1. Extension:



BM = 8.55 kNm

Beam Design to AS 3990

D = 60.0 mm

B = 80.0 mm

t = 6.0 mm

d2 = 30.0 mm

b2 = 50.0 mm

Corners, (Ri/t = 1.50

(Ri = 9.0 mm

(Ro = 15.0 mm

(Ac = 113 mm^2

(ey = 0.545

Fy = 345.00 MPa

Calculate properties about X--X axis:

	Area	1st mt about top	Y	A x Y^2	2nd mt	Ix
B2 flat	300	900	27.0	0.22	0.00	0.22
2 corners	226	1849	21.8	0.11	0.00	0.11
D2 flats	360	10800	0.0	0.00	0.03	0.03

						(8)
2 corners	226	11723	21.8	0.11	0.00	0.11
B2 flat	300	17100	27.0	0.22	0.00	0.22
	1412	42372				0.68

Ytop = 30.0 mm

Ybot = 30.0 mm

Zx = 22.72 x10^3mm^3

rx = 22.0 mm

A = 1412 mm^2

Mass = 11.09 kg/m

Calculate properties about Y--Y axis:

	Area	Moment about LHS	Y	A x Y^2	2nd mt	Iy
D2 flat	180	540	37.0	0.25	0.001	0.25
2 corners	226	1849	31.8	0.23	0.000	0.23
B2 flats	600	24000	-0.0	0.00	0.125	0.13
2 corners	226	16246	31.8	0.23	0.000	0.23
D2 flat	180	13860	37	0.25	0.001	0.25
	1412	56496				1.08

Yl = 40.0 mm

Yr = 40.0 mm

Zy = 26.93 x10^3mm^3

ry = 27.6 mm

Maximum allowable BENDING stress:

Clause 5.2, Fb = 227.70 MPa

Maximum allowable compressive stress:

Maximum of, Fbc = Fy x 0.60

Fbc = 207.00 MPa

*** OR ***

Formula 5.3(4), Fbc = (0.72-0.12/635*b2/T1*Fy^.5)*Fy

Fbc = 238.31 MPa

	Maximum,	Fbc	=	238.31	MPa
Calculate bending stress:		BM	=	8.55	kNm
	***	Fbc	=	227.70	MPa
	***	fc	=	376.48	MPa

*** Arm overstressed ***

Calculate maximum radius:	Maximum,	BM	=	5.17	kNm
		P	=	14.71	kN
	Maximum radius,	r	=	351.6	mm

Add top & bottom reinforcement:

b	=	50.0	mm			
t	=	3.0	mm	Ixr	=	0.30 x10^6mm^4

Add webb reinforcement:

d	=	48.0	mm			
t	=	15.0	mm	Ixw	=	0.14 x10^6mm^4
			Plus,	IxSHS	=	0.68 x10^6mm^4
			Total,	Ix	=	1.12 x10^6mm^4
				Zx	=	35.49 x10^3mm^3
				BM	=	8.55 kNm
			***	Fbc	=	227.70 MPa
			***	fc	=	241.07 MPa

*** Arm satisfactory in bending ***

Reinforcement length,	L	=	454.4	mm	
Use,	L	=	480.0	mm	

Maximum allowable SHEAR stress:

Effective area	=	360.00	mm^2		
d1/t	=	5.00			
V	=	14.78	kN		
*** Fv	=	127.65	MPa		
*** fv	=	41.07	MPa		

*** Beam O.K.in shear ***

Deflection as per AS 1418.9: Allowable deflection, span/300

Unfactored Pw + Phd = 0.00 kN

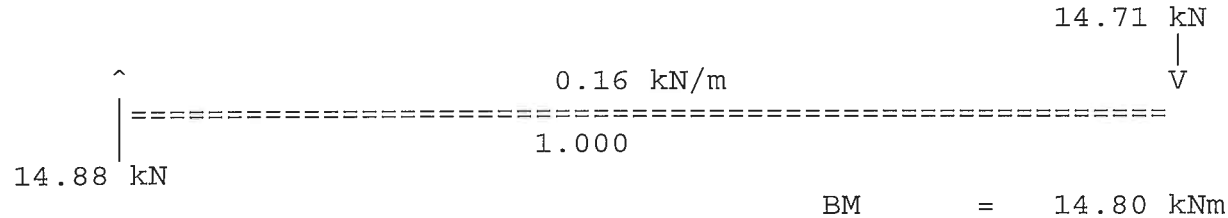
*** Allowable deflection, δ' = 1.9 mm

*** Calculated deflection, δ = 0.0 mm

*** Deflection O.K. ***

2. Main beam:

Effective radius = 1000.0 mm



BM = 14.80 kNm

Beam Design to AS 3990

D = 80.0 mm

B = 100.0 mm

t = 6.0 mm

d2 = 50.0 mm

b2 = 70.0 mm

Corners, (Ri/t = 1.50

(Ri = 9.0 mm

(Ro = 15.0 mm

(Ac = 113 mm^2

(ey = 0.545

Fy = 345.00 MPa

Calculate properties about X--X axis:

	Area	1st mt about top	Y	A x Y^2	2nd mt	Ix
B2 flat	420	1260	37.0	0.57	0.00	0.58
2 corners	226	1849	31.8	0.23	0.00	0.23
D2 flats	600	24000	0.0	0.00	0.13	0.13
2 corners	226	16246	31.8	0.23	0.00	0.23
B2 flat	420	32340	37.0	0.57	0.00	0.58
	1892	75696				1.74

Ytop = 40.0 mm

Ybot = 40.0 mm

Zx = 43.39 x10^3mm^3

rx = 30.3 mm

A = 1892 mm^2

Mass = 14.86 kg/m

Calculate properties about Y--Y axis:

	Area	Moment about LHS	Y	A x Y^2	2nd mt	Iy
D2 flat	300	900	47.0	0.66	0.001	0.66
2 corners	226	1849	41.8	0.40	0.000	0.40
B2 flats	840	42000	-0.0	0.00	0.343	0.34
2 corners	226	20770	41.8	0.40	0.000	0.40
D2 flat	300	29100	47	0.66	0.001	0.66
	1892	94619				2.46

Yl = 50.0 mm

Yr = 50.0 mm

Zy = 49.23 x10^3mm^3

ry = 36.1 mm

Maximum allowable BENDING stress: Fb = 227.70 MPa

Maximum allowable compressive stress: Fbc = Fy x 0.60

Fbc = 207.00 MPa

*** OR ***

Formula 5.3(4), Fbc = (0.72-0.12/635*b2/T1*Fy^.5)*Fy

Fbc = 234.27 MPa

Maximum, Fbc = 234.27 MPa

Calculate bending stress: BM = 14.80 kNm

Clause 5.2 governs, *** Fbc = 227.70 MPa

*** fc = 340.97 MPa

*** Arm overstressed ***

Calculate maximum radius: Maximum, BM = 9.88 kNm

P = 14.71 kN

Maximum radius, r = 671.4 mm

Add top & bottom reinforcement:
---
b = 70.0 mm

t = 3.0 mm Ixw = 0.72 x10^6mm^4

Plus, IxSHS = 1.74 x10^6mm^4

Total, Ix = 2.46 x10^6mm^4

Zx = 59.26 x10^3mm^3

BM = 14.80 kNm

*** Fbc = 234.27 MPa

*** fc = 249.66 MPa

*** Arm satisfactory in bending ***

Reinforcement length, L = 328.6 mm

Use, L = 350.0 mm

Maximum allowable SHEAR stress: Effective area = 600.00 mm^2
---
d1/t = 8.33

V = 14.88 kN

*** Fv = 127.65 MPa

*** fv = 24.79 MPa

*** Beam O.K.in shear ***

Check pivot pins: Grade 5.8 steel.

In shear: BM on pins, BM = 15.45 kNm

Lever arm = 150.0 mm Design load = 103.00 kN

Fuf = 500.00 MPa

Fyf = 400.00 MPa

df = 38.0 mm Area = 1134.11 mm^2

*** Fvf = 125.00 MPa

*** fvf = 90.82 MPa

*** Pin O.K.in shear ***

Check upper lugs:

Lug properties: Design load = 103.00 kN

Fy	=	250.00 MPa				
Radius	=	50.0 mm				
t	=	22.0 mm				
df	=	38.0 mm	Hole diameter	=	38.5 mm	
		Minimum,	*** Ed	=	50.1 mm	
			*** ed	=	50.0 mm	

*** Edge distance satisfactory ***

Check lug in tension: Net area = 1353 mm^2

*** Ft = 150.00 MPa

*** ft = 76.13 MPa

*** O.K. in tension ***

Check lug in bearing:

*** Fpf = 234.96 MPa

*** fpf = 123.21 MPa

*** Bearing stress O.K. ***

Check columns: Columns are connected by an overhead cross member.

There is no direct stress on the columns, because the lift rams transmit the vertical loads to the base.

Check bending only.

See drawing "RACCO01B":

D	=	185.0 mm			
D1	=	30.0 mm	D2	=	160.0 mm
B	=	278.0 mm	D3	=	17.5 mm
B1	=	53.0 mm	B2	=	253.0 mm
T	=	5.0 mm	B3	=	28.0 mm
			Ri/T	=	1.50
		Corners,	Ri	=	7.5 mm
			Ro	=	12.5 mm
			Ac	=	78.54 mm^2

ey = 6.8 mm

b = 28.0 mm

Calculate properties about X--X axis:

	A	Aef	1st mt about top	Y	A x Y^2	2nd mt	Ix
B2, flat	1265	1265	3163	73.5	6.826	0.003	6.83
2 Corners	157	157	1070.1	69.1	0.751	0.000	0.75
D2, flats	1600	1600	148000	16.5	0.438	3.413	3.85
D3, flats	175	175	28656	70.3	0.865	0.004	0.87
B3, flats	280	280	51100	106.5	3.178	0.001	3.18
4 Corners	314	314	55979	102.2	3.283	0.000	3.28
	3791	3791	287968				18.76

Ytop = 76.0 mm

Ybot = 109.0 mm

Zten = 247.01 x10^3mm^3

Zcom = 172.06 x10^3mm^3

Ae = 3791 mm^2

Mass = 29.76 kg/m

rx = 70.3 mm

Calculate properties about Y--Y axis:

	Aef	1st mt about LHS	Y	A x Y^2	2nd mt	Iy
B2, flat	1265	175835	0.0	0.000	6.748	6.75
L Corner	79	535	132.2	1.372	0.000	1.37
R Corner	79	21299	132.2	1.372	0.000	1.37
D2, flat L	800	2000	136.5	14.906	0.002	14.91
D2, flat R	800	220400	136.5	14.906	0.002	14.91
B3 flat L	140	3710	112.5	1.772	0.009	1.78
B3 flat R	140	35210	112.5	1.772	0.009	1.78
L Corner L	79	535	132.2	1.372	0.000	1.37
L Corner R	79	3628	79.2	0.492	0.000	0.49

						(15)
R Corner L	79	18207	79.2	0.492	0.000	0.49
R Corner R	79	21299	132.2	1.372	0.000	1.37
D3, flat L	88	4419	83.5	0.610	0.000	0.61
D3, flat R	88	19906	83.5	0.610	0.000	0.61
	3791	526982				47.82

YLHS = 139.0 mm

YRHS = 139.0 mm

Zy = 344.03 x10^3mm^3

Fy = 345.00 MPa

ry = 112.3 mm

Check column bending due to eccentrticity,

Rear arm: Length = 1050.0 mm

Angle to column = 45.00 deg

Arm lever arm = 742.5 mm

Pin to col N/A = 159.0 mm

Total lever arm = 901.5 mm

60% ratio force = 14.71 kN

Column moment = 13.27 kNm

Front arm: Length = 1462.0 mm

Angle to column = 45.00 deg

Arm lever arm = 1033.8 mm

Pin to col N/A = 159.0 mm

Total lever arm = 1192.8 mm

40% ratio force = 9.81 kN

Column moment = 11.70 kNm

X - X moment on column = 24.97 kNm

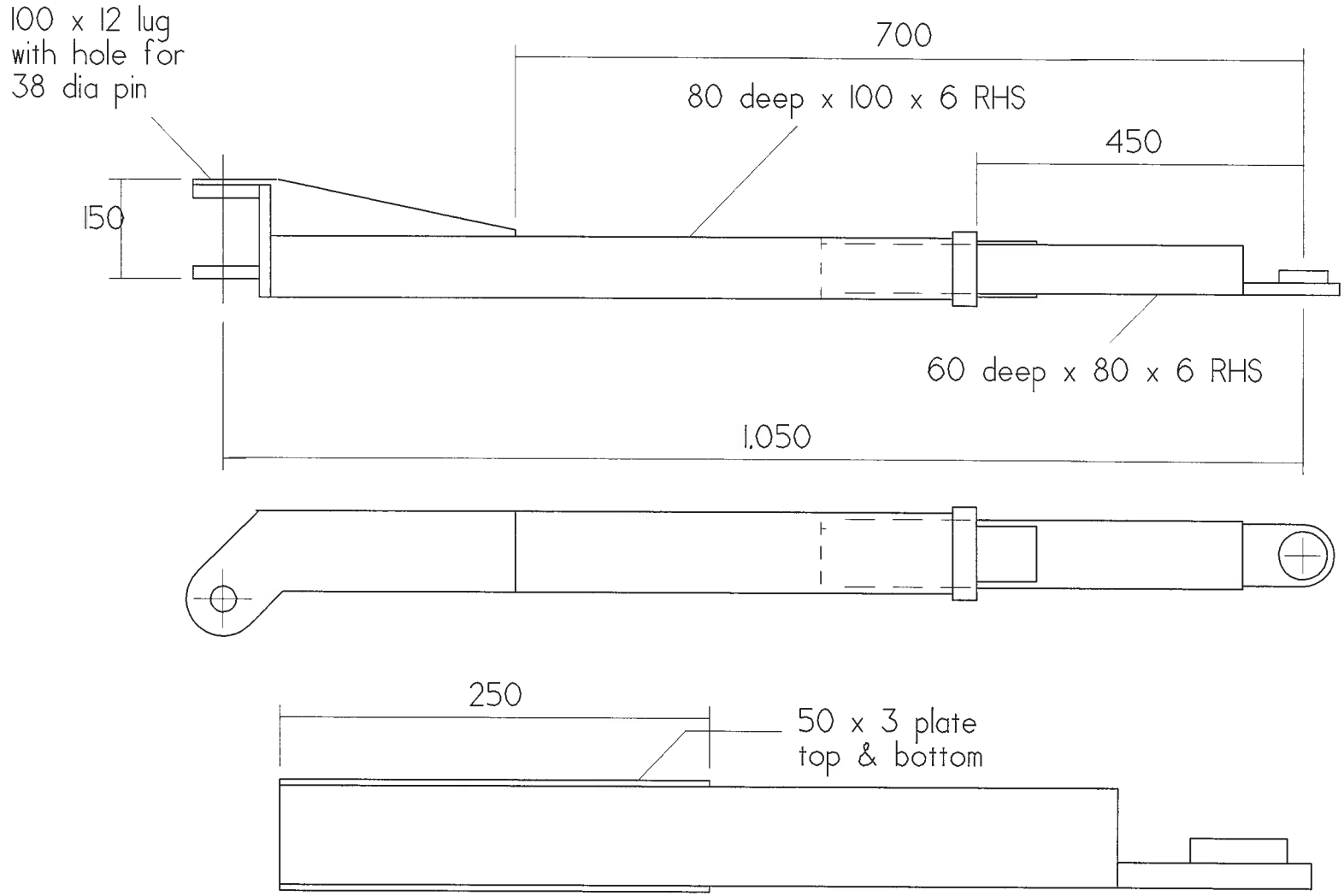
Calculate bending stress:

*** Fbc = 207.00 MPa

*** fc = 145.11 MPa

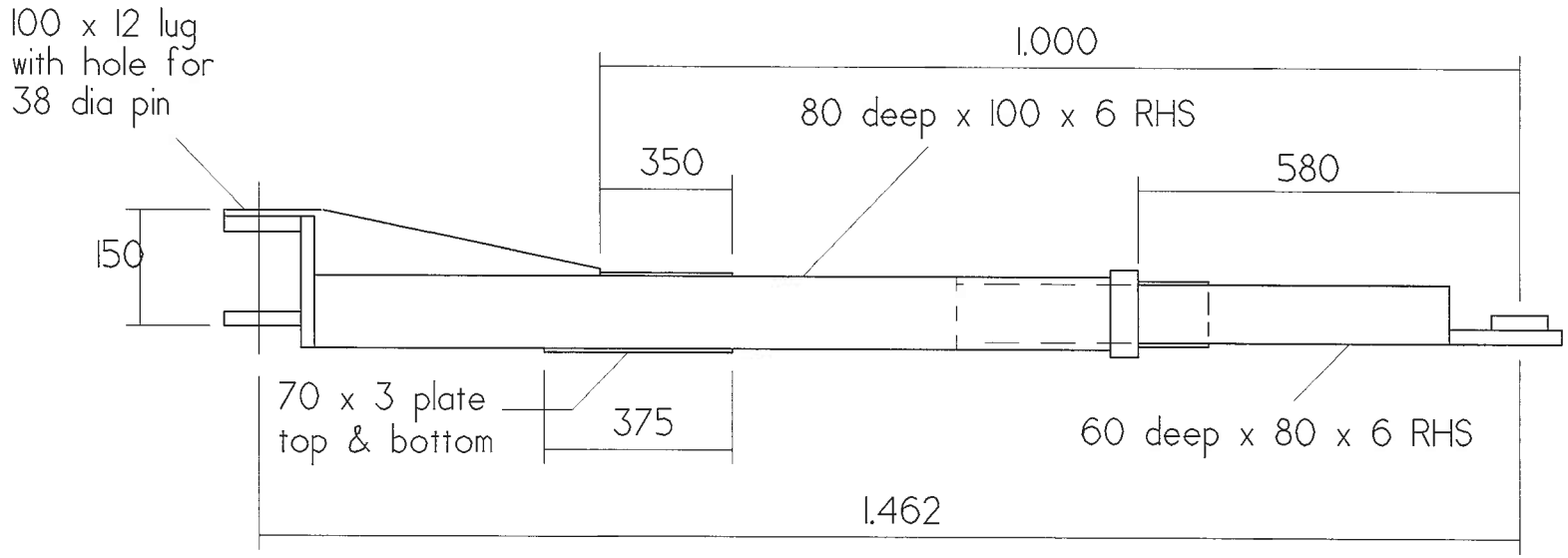
*** ft = 101.08 MPa

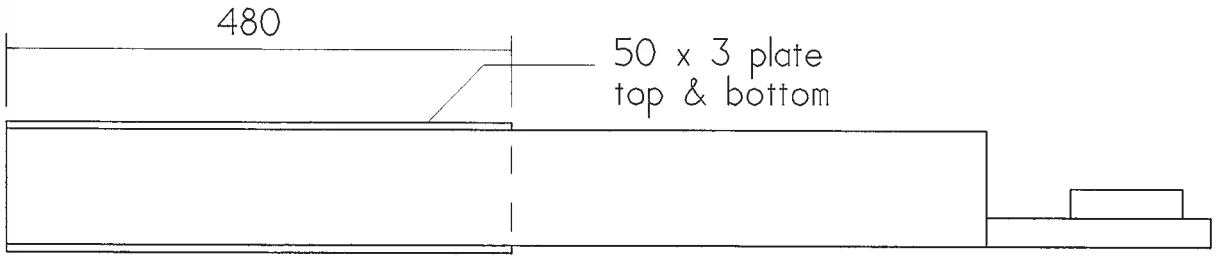
*** Column O.K.in bending ***

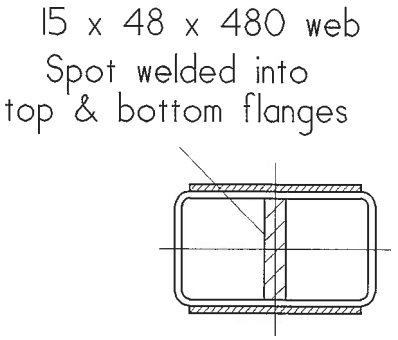


Grade Q345 steel 9K0H 4.00 t Revision 1

A.A.Barnes & Coy.Pty.Ltd. 41 Evans Ct,Toorak 3142	Tel : (03) 9822 5889 Fax : (03) 9822 5542	NOT to scale	4 Feb 12	TUF090H 5

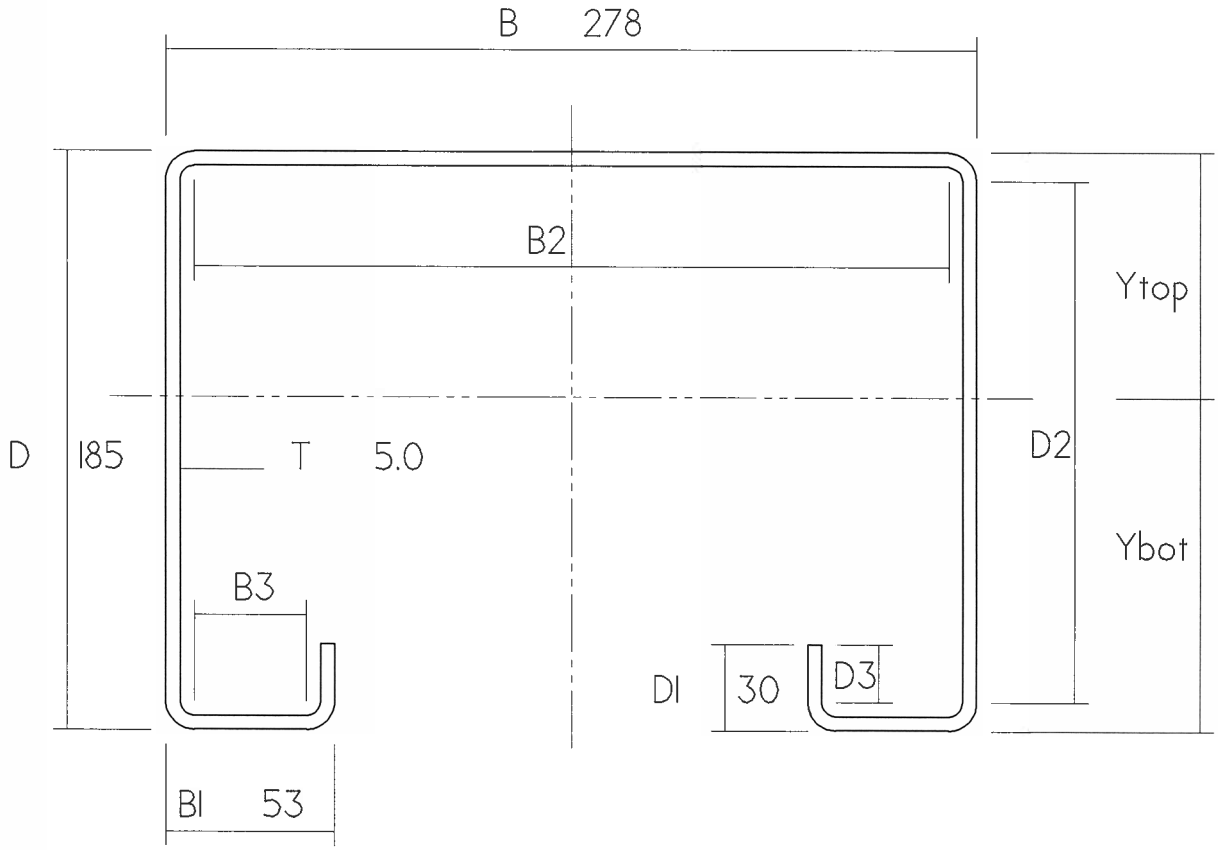






Grade Q345 steel 9K0H 4.00 t Revision 1

A.A.Barnes & Coy.Pty.Ltd. 41 Evans Ct, Toorak 3142	Tel : (03) 9822 5889 Fax : (03) 9822 5542	NOT to scale	4 Feb 12	TUF090H 6



Ix	= 18.76	x10^6mm^4
Ztop	= 247.01	x10^3mm^3
Zbot	= 172.06	x10^3mm^3
Ae	= 3.791	mm^2
Mass	= 29.76	kg/m
rx	= 70.3	mm
Iy	= 47.82	x10^6mm^4
Zy	= 344.03	x10^3mm^3
ry	= 112.3	mm

Columns

Grade Q345 steel

10K0H

A.A.Barnes & Coy.Pty.Ltd.
41 Evans Ct, Toorak 3142

Tel : (03) 9822 5889
Fax : (03) 9822 5542

NOT to scale

20 Nov 11

RACC001B