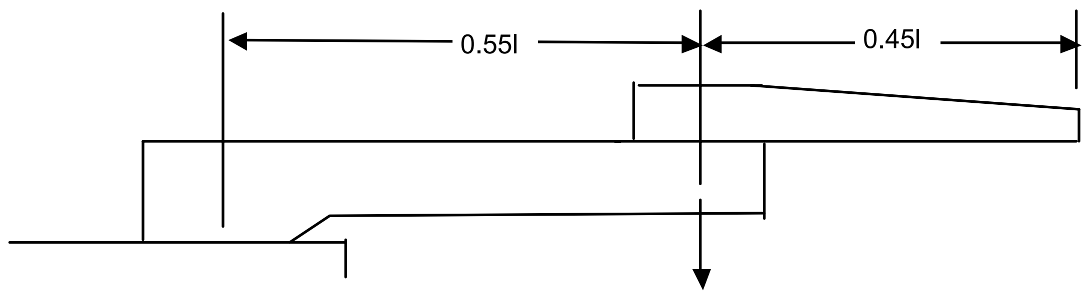
Double Arm 55/45 - 3 Fixed Pedestal Cranes



Boom length = 178 ft | 178 ft | **Total Boom Weight =** | 112,019

Boom of crane needs to support bending moment and shear from its own weight, payload, and internal operating hardware.

The moments in the boom will be calculated at the Pedestal, 0.3l, 0.6l and 0.8l

Weight of crane boom = w (lb/ft) — Assumed to vary linearly along length of

Assume boom weighs 1,000 lb/ft at pedestal and 500 lb/ft at tip

P = Payload weight + Spreader Assembly weight = 80,000 lbs + 10,000 lbs = 90,000

S = Slew ring weight + associated machinery and drives + foundation structure
= 15,000 lbs + 4(5000 lbs) + 100% of this total for foundation structure = 70,000

For ice load calculation the following boom dimensions are assumed:

Ice load = 7 psf

Height of inner boom =	10	ft	Height of outer boom =	7.5
Breadth of inner boom =	10	ft	Breadth of outer boom =	7.5
Length of inner boom =	97.9	ft	Length of outer boom =	80.1

Area of boom for ice load calculations =

40	ft**2/ft of inner boom =	280	lb/ft of inner boom
30	ft**2/ft of outer boom =	210	lb/ft of outer boom

Moment in boom at Pedestal due to ice only = Mice = 3,696,467 ft-lbs

For moment calculation in boom due to deadweight and machinery:

For input to moment calculation w = : 500 lb/ft and W = 44,500

Moment in Boom at Pedestal due to deadwt and mchnry only = Mdeadwt =

Mdeadwt = 33,434,333 ft-lbs

The total moment acting in the boom at the pedestal = Mtot = 37,130,800 ft-lbs

Assume high strength steel Fy = 100 ksi
The allowable stress will be taken as 60% of Fy = 60 ksi 60 ksi

The required section modulus in the boom at the pedestal = 7426.2 in**3

MOMENT CALCULATION AT 0.3l

0.3l = 53.4 ft 0.7l = 124.6 ft

Moment @ 0.3l due to ice:
1,699,451 ft-lbs

Moment @ 0.3l due to deadweight and machinery:

19,115,924 ft-lbs

Total Moment @ 0.3l: 20,815,375 ft-lbs

Section modulus required @ 0.3l: 4163.1 in**3 Assuming 100 ksi steel

MOMENT CALCULATION AT 0.6l

0.6l= 106.8 ft 0.4l = 71.2 ft

Moment @ 0.6l due to ice:
532,291 ft-lbs

Moment @ 0.6l due to deadweight and machinery:

7,844,341 ft-lbs

Total moment at 0.6l: 8,376,633 ft-lbs

Section modulus required @ 0.6l: 1675.3 in**3 Assuming 100 ksi steel

MOMENT CALCULATION AT 0.8l

0.8l = **142.4** ft   0.2l = **35.6** ft

Moment @ 0.8l due to ice:

133,073 ft-lbs

Moment @ 0.8l due to deadweight and machinery:

3,541,963 ft-lbs

Total moment @ 0.8l: **3,675,035** ft-lbs

Section modulus required @ 0.8l: **735.0** in**3

SUMMARY

LOCATION	Smreqd	1.1x SMreqd
Pedestal	**7426.2**	8168.8
0.3l	**4163.1**	4579.4
0.6l	**1675.3**	1842.9
0.8l	**735.0**	808.5

Outboard Arm Rotated 90 Degrees

The following section of calculations will determine the boom strength requirements with the outboard arm rotated 90 degrees.

This is only critical for the inboard arm and base reactions - there is no change to the requirements on the outboard arm.

This calculation assumes that the outboard arm will impart a moment and a reaction to the outer end of the inboard arm. The moment and reaction will be the result of ice loads, structural deadweight, container payload and spreader assembly.

Ice load on outer boom = **210** lbs/ft = **22,428** lbs
and a moment of **673,681** ft-lbs at the outer end of inner arm

Payload & spreader assembly = **90,000** lbs
and a moment of **7,209,000** ft-lbs at the outer end of the inner arm

Structural deadweight of outer arm =	700	lbs/ft at inner end
	500	lbs/ft at outer end
	48,060	lbs
and a moment of	1,817,870	

Total reaction @ outer end of inner arm due to outer arm:	160,488	lbs
with a torsional moment of:	9,700,551	ft-lbs
Moment at Pedestal due to outer arm reactions:	15,711,775	ft-lbs
plus torsional moment of:	9,700,551	ft-lbs
Moment @ Pedestal due to ice load on inner arm:	1,341,817	ft-lbs
Moment @ Pedestal due to slew ring components:	6,853,000	ft-lbs

Structural deadweight of inner arm:	1,000	lbs/ft at inner end
	700	lbs/ft at outer end
	83,215	lbs
and a moment of:	3,833,764	ft-lbs
Moments to be resisted at Pedestal:	27,740,357	ft-lbs
plus a torsional moment of	9,700,551	ft-lbs

60/40 DOUBLE ARM CRANE - PEDESTAL BASE

SECTION PROPERTY CALCULATIONS FOR CRANE BOOM

SECTION FROM PEDESTAL TO 0.3L

Minimum SM Reqd = **8168.8** in3

Moment @ Pedestal = **37,130,800** ft-lbs

	Breadth	Thickness	A (in^2)	y (in)	Ay (in^3)	Ay² (in^4)
pper Flange	120.00	0.375	45.00	0.19	8.44	1.58
Stiffs - Upper Flg			14.28	1.3	18.564	24.1332
tiffener Web	120.00	1.000	120.00	60.38	7245.00	437417
Stiffs - lower flg			14.28	119	1699.32	202219
ower Flange	120.00	0.500	60.00	120.63	7237.50	873023
Σ =			253.56		16208.82	1512685
			862.1 lb/ft			

Summary properties :			
D - Overall Depth	**120.88**	in	fb
Y_{FLG} - dist. to Neutral Axis from upper flange	**63.92**	in	
Y_{PL} - dist. to Neutral Axis from lower flange	**56.95**	in	
I_{YY} - Moment of Inertia y-y (parallel to deck)	**620,538**	in^4	
Z_{FLG} - Section Modulus Upper Flange	**9,707**	in^3	**50,491**
Z_{PL} - Section Modulus Lower Flange	**10,896**	in^3	**44,981**
A - Axial Area	**253.56**	in^2	b/t=(120/8)/
V_S - Shear Area	**148.56**	in^2	
I_{ZZ} - Moment of Inertia z-z (normal to deck)	**72,000.00**	in^4	
r_{YY} - radius of gyration	**49.47**	in	
r_{ZZ} - radius of gyration	**#DIV/0!**	in	

60/40 DOUBLE ARM CRANE - PEDESTAL BASE

SECTION PROPERTY CALCULATIONS FOR CRANE BOOM

SECTION FROM 0.3L TO 0.6L Minimum SM Reqd = **4579.4**

Moment @ 0.3L = **20,815,375** ft-lbs

	Breadth	Thickness	A (in^2)	y (in)	Ay (in^3)	Ay² (in^4)
pper Flange	120.00	0.250	30.00	0.13	3.75	0.47
Stiffs - Upper Flg			14.28	1.3	18.564	24.1332
tiffener Web	120.00	0.750	90.00	60.25	5422.50	326706
Stiffs - lower flg			14.28	119	1699.32	202219
wer Flange	120.00	0.375	45.00	120.44	5419.69	652734
Σ =			193.56		12563.82	1181683
			658.1	lb/ft		

Summary properties :

D - Overall Depth	**120.63**	in	fb
Y_{FLG} - dist. to Neutral Axis from upper flange	**64.91**	in	
Y_{PL} - dist. to Neutral Axis from lower flange	**55.72**	in	
I_{YY} - Moment of Inertia y-y (parallel to deck)	**474,176**	in^4	
Z_{FLG} - Section Modulus Upper Flange	**7,305**	in^3	**37,612**
Z_{PL} - Section Modulus Lower Flange	**8,511**	in^3	**32,285**
A - Axial Area	**193.56**	in^2	b/t=(120/8)/
V_S - Shear Area	**118.56**	in^2	
I_{ZZ} - Moment of Inertia z-z (normal to deck)	**54,000.00**	in^4	
r_{YY} - radius of gyration	**49.50**	in	
r_{ZZ} - radius of gyration	**#DIV/0!**	in	

60/40 DOUBLE ARM CRANE - PEDESTAL BASE

SECTION PROPERTY CALCULATIONS FOR CRANE BOOM

SECTION FROM 0.6L to 0.8L Minimum SM Reqd = **1842.9** in3

Moment @ 0.6L = **8,376,633** ft-lbs

	Breadth	Thickness	A (in^2)	y (in)	Ay (in^3)	Ay² (in^4)
pper Flange	18.00	0.375	6.75	0.19	1.27	0.24
Stiffs - Upper Flg			0	1.3	0	0
tiffener Web	90.00	0.625	56.25	45.38	2552.34	115813
Stiffs - lower flg			10.2	89	907.8	80794.2
ɔwer Flange	90.00	0.375	33.75	90.56	3056.48	276803
Σ =			106.95		6517.89	473410
			363.6	lb/ft		

Summary properties :

D - Overall Depth	**90.75**	in	fb
Y_{FLG} - dist. to Neutral Axis from upper flange	**60.94**	in	
Y_{PL} - dist. to Neutral Axis from lower flange	**29.81**	in	
I_{YY} - Moment of Inertia y-y (parallel to deck)	**114,157**	in^4	
Z_{FLG} - Section Modulus Upper Flange	**1,873**	in^3	**59,029**
Z_{PL} - Section Modulus Lower Flange	**3,830**	in^3	**28,871**
A - Axial Area	**106.95**	in^2	b/t=(90/6)/.:

V_S - Shear Area	**66.45**	in^2
I_{ZZ} - Moment of Inertia z-z (normal to deck)	**22,781.25**	in^4
r_{YY} - radius of gyration	**32.67**	in
r_{ZZ} - radius of gyration	**#DIV/0!**	in

60/40 DOUBLE ARM CRANE - PEDESTAL BASE

SECTION PROPERTY CALCULATIONS FOR CRANE BOOM

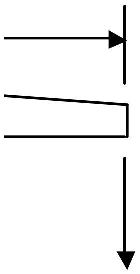
SECTION FROM 0.8L to boom tip Minimum SM Reqd = **808.5**

Moment @ 0.8L = **3,675,035** ft-lbs

	Breadth	Thickness	A (in^2)	y (in)	Ay (in^3)	Ay² (in^4)
pper Flange	18.00	0.375	6.75	0.19	1.27	0.24
Stiffs - Upper Flg			0	1.3	0	0
tiffener Web	90.00	0.500	45.00	45.38	2041.88	92650
Stiffs - lower flg			10.2	89	907.8	80794.2
›wer Flange	90.00	0.250	22.50	90.50	2036.25	184281
Σ =			84.45		4987.19	357725
			287.1	lb/ft		

Summary properties :

D - Overall Depth	**90.63**	in	fb
Y_{FLG} - dist. to Neutral Axis from upper flange	**59.05**	in	
Y_{PL} - dist. to Neutral Axis from lower flange	**31.57**	in	
I_{YY} - Moment of Inertia y-y (parallel to deck)	**93,582**	in^4	
Z_{FLG} - Section Modulus Upper Flange	**1,585**	in^3	**30,613**
Z_{PL} - Section Modulus Lower Flange	**2,964**	in^3	**16,365**
A - Axial Area	**84.45**	in^2	b/t=(90/6)/.:
V_S - Shear Area	**55.20**	in^2	
I_{ZZ} - Moment of Inertia z-z (normal to deck)	**15,187.50**	in^4	
r_{YY} - radius of gyration	**33.29**	in	
r_{ZZ} - radius of gyration	**#DIV/0!**	in	



pounds

boom

lbs

lbs

ft
ft
ft

lbs

I_O (in^4)
0.53
144000
1.25
144002

Fb

60,000

52,800

/.5=30

in3

I_O (in^4)
0.16
108000
0.53
108001

Fb

60,000

40,200

/.375=34.2

I_O (in^4)
0.08
37969
0.40
37969

Fb

60,000

40,200

375=40

in3

I_O (in^4)
0.08
30375
0.12
30375

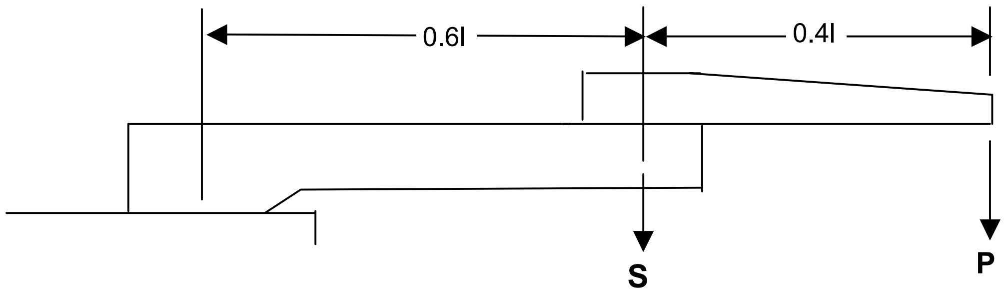
Fb

60,000

17,880

25=60

Double Arm - Track



Boom length = 130 ft 130 ft **Total Boom Weight =** 68,850 **pounds**

Boom of crane needs to support bending moment and shear from its own weight, payload, and internal operating hardware.

The moments in the boom will be calculated at the Pedestal, 0.3l, 0.6l and 0.8l

Weight of crane boom = w (lb/ft) Assumed to vary linearly along length of boom

Assume boom weighs 750 lb/ft at pedestal and 400 lb/ft at tip

P = Payload weight + Spreader Assembly weight = 80,000 lbs + 10,000 lbs = 90,000 lbs
S = Slew ring weight + associated machinery and drives + foundation structure
= 15,000 lbs + 4(5000 lbs) + 100% of this total for foundation structure = 70,000 lbs

For ice load calculation the following boom dimensions are assumed:

Ice load = 7 psf

Height of inner boom =	10 ft	Height of outer boom =	7.5 ft
Breadth of inner boom =	10 ft	Breadth of outer boom =	7.5 ft
Length of inner boom =	78 ft	Length of outer boom =	52 ft

Area of boom for ice load calculations =

40 ft**2/ft of inner boom = 280 lb/ft of inner boom
30 ft**2/ft of outer boom = 210 lb/ft of outer boom

Moment in boom at Pedestal due to ice only = Mice = 1,971,667 ft-lbs

For moment calculation in boom due to deadweight and machinery:

For input to moment calculation w = : 400 lb/ft and W = 22,750 lbs

Moment in Boom at Pedestal due to deadwt and mchnry only = Mdeadwt =

Mdeadwt = 21,525,833 ft-lbs

The total moment acting in the boom at the pedestal = Mtot = **23,497,500** ft-lbs

Assume high strength steel Fy = **100** ksi
The allowable stress will be taken as 60% of Fy = 60 ksi **60** ksi

The required section modulus in the boom at the pedestal = **4699.5** in**3

MOMENT CALCULATION AT 0.3l

0.3l = **39** ft 0.7L = **91** ft

Moment @ 0.3l due to ice:
922,740 ft-lbs

Moment @ 0.3l due to deadweight and machinery:

12,914,341 ft-lbs

Total Moment @ 0.3l: **13,837,081** ft-lbs

Section modulus required @ 0.3l: **2767.4** in**3 Assuming 100 ksi steel

MOMENT CALCULATION AT 0.6l

0.6l= **78** ft 0.4l = **52** ft

Moment @ 0.6l due to ice:
283,920 ft-lbs

Moment @ 0.6l due to deadweight and machinery:

5,283,893 ft-lbs

Total moment at 0.6l: **5,567,813** ft-lbs

Section modulus required @ 0.6l: **1113.6** in**3 Assuming 100 ksi steel

MOMENT CALCULATION AT 0.8l

0.8l = **104** ft 0.2l = **26** ft

Moment @ 0.8l due to ice:
70,980 ft-lbs

Moment @ 0.8l due to deadweight and machinery:

2,483,087 ft-lbs

Total moment @ 0.8l: **2,554,067** ft-lbs

Section modulus required @ 0.8l: **510.8** in**3

SUMMARY

LOCATION	Smreqd	1.1x SMreqd
Pedestal	**4699.5**	5169.5
0.3l	**2767.4**	3044.2
0.6l	**1113.6**	1224.9
0.8l	**510.8**	561.9

Outboard Arm Rotated 90 Degrees

The following section of calculations will determine the boom strength requirements with the outboard arm rotated 90 degrees.

This is only critical for the inboard arm and base reactions - there is no change to the requirements on the outboard arm.

This calculation assumes that the outboard arm will impart a moment and a reaction to the outer end of the inboard arm. The moment and reaction will be the result of ice loads, structural deadweight, container payload and spreader assembly.

Ice load on outer boom = **210** lbs/ft = **10,920** lbs
and a moment of **283,920** ft-lbs at the outer end of inner arm

Payload & spreader assembly = **90,000** lbs
and a moment of **4,680,000** ft-lbs at the outer end of the inner arm

Structural deadweight of outer arm = **540** lbs/ft at inner end
400 lbs/ft at outer end
24,440 lbs
and a moment of **603,893** `

Total reaction @ outer end of inner arm due to outer arm: **125,360** lbs
with a torsional moment of: **5,567,813** ft-lbs

Moment at Pedestal due to outer arm reactions: **9,778,080** ft-lbs
plus torsional moment of: **5,567,813** ft-lbs

Moment @ Pedestal due to ice load on inner arm: **851,760** ft-lbs

Moment @ Pedestal due to slew ring components: **5,460,000** ft-lbs

Structural deadweight of inner arm:	750	lbs/ft at inner end
	540	lbs/ft at outer end
	50,310	lbs
and a moment of:	1,855,620	ft-lbs
Moments to be resisted at Pedestal:	17,945,460	ft-lbs
plus a torsional moment of	5,567,813	ft-lbs

60/40 DOUBLE ARM CRANE - TRAVELLING CRANE

SECTION PROPERTY CALCULATIONS FOR CRANE BOOM

SECTION FROM PEDESTAL TO 0.3L Minimum SM Reqd = **5169.5** in3

Moment @ Pedestal = **23,497,500** ft-lbs

	Breadth	Thickness	A (in^2)	y (in)	Ay (in^3)	Ay^2 (in^4)	I_O (in^4)
pper Flange	120.00	0.250	30.00	0.13	3.75	0.47	0.16
Stiffs - Upper Flg			14.28	1.3	18.564	24.1332	
iffener Web	120.00	0.750	90.00	60.25	5422.50	326706	108000
Stiffs - lower flg			14.28	119	1699.32	202219.1	
wer Flange	120.00	0.375	45.00	120.44	5419.69	652734	0.53
Σ =			193.56		12563.82	1181683	108001
			658.1 lb/ft				

Summary properties :

			fb	Fb
D - Overall Depth	**120.63**	in		
Y_{FLG} - dist. to Neutral Axis from upper flange	**64.91**	in		
Y_{PL} - dist. to Neutral Axis from lower flange	**55.72**	in		
I_{YY} - Moment of Inertia y-y (parallel to deck)	**474,176**	in^4		
Z_{FLG} - Section Modulus Upper Flange	**7,305**	in^3	**42,458**	60,000
Z_{PL} - Section Modulus Lower Flange	**8,511**	in^3	**36,445**	40,200
A - Axial Area	**193.56**	in^2	b/t=(120/8)/.375=40	
V_S - Shear Area	**118.56**	in^2		
I_{ZZ} - Moment of Inertia z-z (normal to deck)	**54,000.00**	in^4		
r_{YY} - radius of gyration	**49.50**	in		
r_{ZZ} - radius of gyration	**#DIV/0!**	in		

60/40 DOUBLE ARM CRANE - TRAVELLING CRANE

SECTION PROPERTY CALCULATIONS FOR CRANE BOOM

SECTION FROM 0.3L TO 0.6L Minimum SM Reqd = **3044.2** in3

Moment @ 0.3L = **13,837,081** ft-lbs

	Breadth	Thickness	A (in^2)	y (in)	Ay (in^3)	Ay² (in^4)	I_O (in^4)
pper Flange	120.00	0.250	30.00	0.13	3.75	0.47	0.16
Stiffs - Upper Flg			14.28	1.3	18.564	24.1332	
iffener Web	120.00	0.625	75.00	60.25	4518.75	272255	90000
Stiffs - lower flg			14.28	119	1699.32	202219.1	
ower Flange	120.00	0.313	37.50	120.41	4515.23	543662	0.31
Σ =			171.06		10755.62	1018161	90000
			581.6 lb/ft				

Summary properties :

			fb	Fb
D - Overall Depth	**120.56**	in		
Y_{FLG} - dist. to Neutral Axis from upper flange	**62.88**	in		
Y_{PL} - dist. to Neutral Axis from lower flange	**57.69**	in		
I_{YY} - Moment of Inertia y-y (parallel to deck)	**431,888**	in^4		
Z_{FLG} - Section Modulus Upper Flange	**6,869**	in^3	**26,591**	60,000
Z_{PL} - Section Modulus Lower Flange	**7,487**	in^3	**24,396**	27,000
A - Axial Area	**171.06**	in^2	b/t=(120/8)/.3125=48	
V_S - Shear Area	**103.56**	in^2		
I_{ZZ} - Moment of Inertia z-z (normal to deck)	**45,000.00**	in^4		
r_{YY} - radius of gyration	**50.25**	in		
r_{ZZ} - radius of gyration	**#DIV/0!**	in		

60/40 DOUBLE ARM CRANE - TRAVELLING CRANE

SECTION PROPERTY CALCULATIONS FOR CRANE BOOM

SECTION FROM 0.6L to 0.8L Minimum SM Reqd = **1224.9** in3

Moment @ 0.6l = **5,567,813** ft-lbs

	Breadth	Thickness	A (in^2)	y (in)	Ay (in^3)	Ay² (in^4)	I_O (in^4)
pper Flange	15.00	0.375	5.63	0.19	1.05	0.20	0.07
Stiffs - Upper Flg			0	1.3	0	0	
iffener Web	90.00	0.625	56.25	45.38	2552.34	115813	37969
Stiffs - lower flg			10.2	89	907.8	80794.2	
ower Flange	90.00	0.313	28.13	90.53	2546.19	230510	0.23

Σ =			100.20		6007.39	427117	37969
			340.7 lb/ft				

Summary properties :

D - Overall Depth	**90.69**	in	fb	Fb
Y_{FLG} *- dist. to Neutral Axis from upper flange*	**59.95**	in		
Y_{PL} *- dist. to Neutral Axis from lower flange*	**30.73**	in		
I_{YY} *- Moment of Inertia y-y (parallel to deck)*	**104,919**	in^4		
Z_{FLG} *- Section Modulus Upper Flange*	**1,750**	in^3	**41,997**	60,000
Z_{PL} *- Section Modulus Lower Flange*	**3,414**	in^3	**21,529**	27,000
A - Axial Area	**100.20**	in^2	b/t=(90/6)/.3125=48	
V_S *- Shear Area*	**66.45**	in^2		
I_{ZZ} *- Moment of Inertia z-z (normal to deck)*	**18,984.38**	in^4		
r_{YY} *- radius of gyration*	**32.36**	in		
r_{ZZ} *- radius of gyration*	**#DIV/0!**	in		

60/40 DOUBLE ARM CRANE - TRAVELLING CRANE

SECTION PROPERTY CALCULATIONS FOR CRANE BOOM

SECTION FROM 0.8L to boom tip Minimum SM Reqd = **561.9** in3

Moment @ 0.8l = **2,554,067** ft-lbs

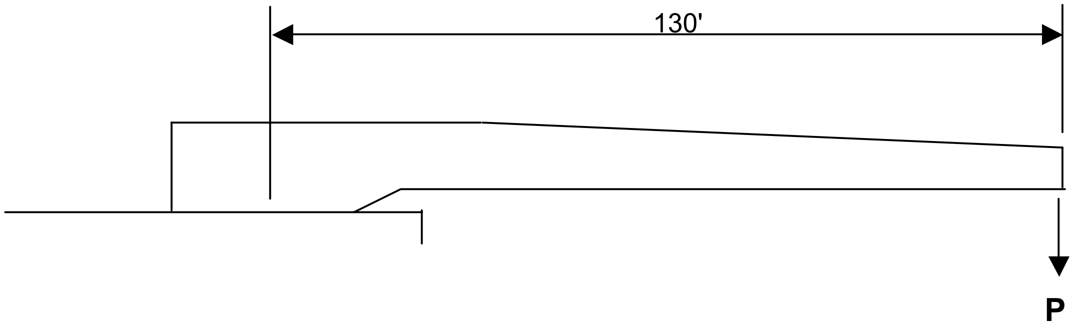
	Breadth	Thickness	A (in^2)	y (in)	Ay (in^3)	Ay² (in^4)	I_O (in^4)
pper Flange	15.00	0.375	5.63	0.19	1.05	0.20	0.07
Stiffs - Upper Flg			0	1.3	0	0	
iffener Web	90.00	0.500	45.00	45.38	2041.88	92650	30375
Stiffs - lower flg			10.2	89	907.8	80794.2	
wer Flange	90.00	0.250	22.50	90.50	2036.25	184281	0.12
Σ =			83.33		4986.98	357725	30375
			283.3 lb/ft				

Summary properties :

D - Overall Depth	**90.63**	in	fb	Fb
Y_{FLG} *- dist. to Neutral Axis from upper flange*	**59.85**	in		
Y_{PL} *- dist. to Neutral Axis from lower flange*	**30.78**	in		
I_{YY} *- Moment of Inertia y-y (parallel to deck)*	**89,631**	in^4		
Z_{FLG} *- Section Modulus Upper Flange*	**1,498**	in^3	**22,512**	60,000
Z_{PL} *- Section Modulus Lower Flange*	**2,912**	in^3	**11,576**	17,880
A - Axial Area	**83.33**	in^2	b/t=(90/6)/.25=60	
V_S *- Shear Area*	**55.20**	in^2		

I_{ZZ} - Moment of Inertia z-z (normal to deck)	**15,187.50**	in^4
r_{YY} - radius of gyration	**32.80**	in
r_{ZZ} - radius of gyration	**#DIV/0!**	in

Single Arm - Travel



Boom length = 130 ft **130** ft **Total Boom Weight =** **53,887** **pounds**

Boom of crane needs to support bending moment and shear from its own weight, payload, and internal operating hardware.

The moments in the boom will be calculated at the Pedestal, 0.2l, 0.4l and 0.7l

Weight of crane boom = w (lb/ft) Assumed to vary linearly along length of boom

Assume boom weighs **750** lb/ft at pedestal and **400** lb/ft at tip

P = Payload weight + Spreader Assembly weight = 80,000 lbs + 10,000 lbs = **90,000** lbs
S = Slew ring weight + associated machinery and drives + foundation structure
= 15,000 lbs + 4(5000 lbs) + 100% of this total for foundation structure = **-** lbs

For ice load calculation the following boom dimensions are assumed:

Ice load = **7** psf

Height of inner boom =	**10** ft	Height of outer boom =	**8** ft
Breadth of inner boom =	**10** ft	Breadth of outer boom =	**8** ft
Length of inner boom =	**52** ft	Length of outer boom =	**78** ft

Area of boom for ice load calculations =

40 ft**2/ft of inner boom = **280** lb/ft of inner boom
32 ft**2/ft of outer boom = **224** lb/ft of outer boom

Moment in boom at Pedestal due to ice only = Mice = **2,050,533** ft-lbs

For moment calculation in boom due to deadweight and machinery:

For input to moment calculation w = : **400** lb/ft and W = **22,750** lbs

Moment in Boom at Pedestal due to deadwt and mchnry only = Mdeadwt =

Mdeadwt = **16,065,833** ft-lbs

The total moment acting in the boom at the pedestal = Mtot = 18,116,367 ft-lbs

Assume high strength steel Fy = 100 ksi
The allowable stress will be taken as 60% of Fy = 60 ksi 60 ksi

The required section modulus in the boom at the pedestal = 3623.3 in**3

MOMENT CALCULATION AT 0.2l

0.2l = 26 ft 0.8 = 104 ft

Moment @ 0.2l due to ice:
1,230,320 ft-lbs

Moment @ 0.2l due to deadweight and machinery:

12,027,947 ft-lbs

Total Moment @ 0.2l: 13,258,267 ft-lbs

Section modulus required @ 0.2l: 2651.7 in**3 Assuming 100 ksi steel

MOMENT CALCULATION AT 0.4l

0.4l= 52 ft 0.6l = 78 ft

Moment @ 0.4l due to ice:
681,408 ft-lbs

Moment @ 0.4l due to deadweight and machinery:

8,449,740 ft-lbs

Total moment at 0.4l: 9,131,148 ft-lbs

Section modulus required @ 0.4l: 1826.2 in**3 Assuming 100 ksi steel

MOMENT CALCULATION AT 0.7l

0.7l = 91 ft 0.3l = 39 ft

Moment @ 0.7l due to ice:
170,352 ft-lbs

Moment @ 0.4l due to deadweight and machinery:

3,840,818 ft-lbs

Total moment @ 0.7l: 4,011,170 ft-lbs

Section modulus required @ 0.7l: 802.2 in**3

SUMMARY

LOCATION	Smreqd	1.1x SMreqd
Pedestal	3623.3	3985.6
0.2l	2651.7	2916.8
0.4l	1826.2	2008.9
0.7l	802.2	882.5

SINGLE ARM TRAVELLING CRANE

SECTION PROPERTY CALCULATIONS FOR CRANE BOOM

SECTION FROM PEDESTAL TO 0.2L Minimum SM Reqd = **3985.6** in3

Moment @ Pedestal = **18,116,367** ft-lbs

	Breadth	Thickness	A (in^2)	y (in)	Ay (in^3)	Ay² (in^4)	I_O (in^4)
pper Flange	30.00	0.313	9.38	0.16	1.46	0.23	0.08
Stiffs - Upper Flg			2.04	1.3	2.652	3.4476	
iffener Web	120.00	0.750	90.00	60.31	5428.13	327384	108000
Stiffs - lower flg			14.28	119	1699.32	202219.1	
ower Flange	120.00	0.375	45.00	120.50	5422.50	653411	0.53
Σ =			160.70		12554.06	1183018	108001
			546.4 lb/ft				

Summary properties :

			fb	Fb
D - Overall Depth	**120.69**	in		
Y_{FLG} - dist. to Neutral Axis from upper flange	**78.12**	in		
Y_{PL} - dist. to Neutral Axis from lower flange	**42.56**	in		
I_{YY} - Moment of Inertia y-y (parallel to deck)	**310,251**	in^4		
Z_{FLG} - Section Modulus Upper Flange	**3,971**	in^3	**60,216**	60,000
Z_{PL} - Section Modulus Lower Flange	**7,289**	in^3	**32,808**	40,200
A - Axial Area	**160.70**	in^2	b/t=(120/8)/.375=40	
V_S - Shear Area	**106.32**	in^2		
I_{ZZ} - Moment of Inertia z-z (normal to deck)	**54,000.00**	in^4		
r_{YY} - radius of gyration	**43.94**	in		
r_{ZZ} - radius of gyration	**#DIV/0!**	in		

SINGLE ARM TRAVELLING CRANE

SECTION PROPERTY CALCULATIONS FOR CRANE BOOM

SECTION FROM 0.2L TO 0.4L Minimum SM Reqd = **2916.8** in3

Moment @ 0.2L = **13,258,267** ft-lbs

	Breadth	Thickness	A (in^2)	y (in)	Ay (in^3)	Ay² (in^4)	I_O (in^4)
pper Flange	30.00	0.250	7.50	0.13	0.94	0.12	0.04
Stiffs - Upper Flg			2.04	1.3	2.652	3.4476	
iffener Web	108.00	0.625	67.50	54.25	3661.88	198657	65610
Stiffs - lower flg			14.28	107	1527.96	163491.7	
ower Flange	108.00	0.313	33.80	108.41	3664.57	397264	0.28
Σ =			125.12		8858.00	759416	65610
			425.4 lb/ft				

Summary properties :

			fb	Fb
D - Overall Depth	**108.56**	in	fb	Fb
Y_{FLG} - dist. to Neutral Axis from upper flange	**70.79**	in		
Y_{PL} - dist. to Neutral Axis from lower flange	**37.77**	in		
I_{YY} - Moment of Inertia y-y (parallel to deck)	**197,935**	in^4		
Z_{FLG} - Section Modulus Upper Flange	**2,796**	in^3	**62,594**	60,000
Z_{PL} - Section Modulus Lower Flange	**5,241**	in^3	**33,395**	33,600
A - Axial Area	**125.12**	in^2	b/t=(108/8)/.3125=56	
V_S - Shear Area	**83.82**	in^2		
I_{ZZ} - Moment of Inertia z-z (normal to deck)	**32,857.49**	in^4		
r_{YY} - radius of gyration	**39.77**	in		
r_{ZZ} - radius of gyration	**#DIV/0!**	in		

SINGLE ARM TRAVELLING CRANE

SECTION PROPERTY CALCULATIONS FOR CRANE BOOM

SECTION FROM 0.4L to 0.7L Minimum SM Reqd = **2008.9** in3

Moment @ 0.4L = **9,131,148** ft-lbs

	Breadth	Thickness	A (in^2)	y (in)	Ay (in^3)	Ay² (in^4)	I_O (in^4)
pper Flange	24.00	0.250	6.00	0.13	0.75	0.09	0.03
Stiffs - Upper Flg			2.04	1.3	2.652	3.4476	

iffener Web	96.00	0.625	60.00	48.25	2895.00	139684	46080
Stiffs - lower flg			14.28	95	1356.6	128877	
ower Flange	96.00	0.313	30.00	96.41	2892.19	278825	0.24
Σ =			112.32		7147.19	547389	46080
			381.9 lb/ft				

Summary properties :

			fb	Fb
D - Overall Depth	**96.56**	in		
Y_{FLG} - dist. to Neutral Axis from upper flange	**63.63**	in		
Y_{PL} - dist. to Neutral Axis from lower flange	**32.93**	in		
I_{YY} - Moment of Inertia y-y (parallel to deck)	**138,677**	in^4		
Z_{FLG} - Section Modulus Upper Flange	**2,179**	in^3	**55,306**	60,000
Z_{PL} - Section Modulus Lower Flange	**4,211**	in^3	**28,621**	43,200
A - Axial Area	**112.32**	in^2		
V_S - Shear Area	**76.32**	in^2	b/t=(96/8)/.3125=38.4	
I_{ZZ} - Moment of Inertia z-z (normal to deck)	**23,040.00**	in^4		
r_{YY} - radius of gyration	**35.14**	in		
r_{ZZ} - radius of gyration	**#DIV/0!**	in		

SINGLE ARM TRAVELLING CRANE

SECTION PROPERTY CALCULATIONS FOR CRANE BOOM

SECTION FROM 0.7L to boom tip Minimum SM Reqd = **882.5** in3

Moment @ 0.7L = **4,011,170** ft-lbs

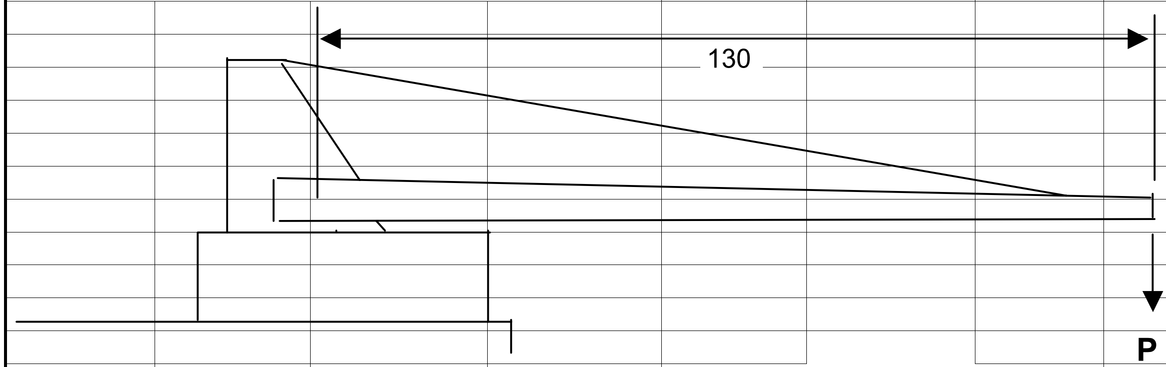
	Breadth	Thickness	A (in^2)	y (in)	Ay (in^3)	Ay² (in^4)	I_O (in^4)
pper Flange	24.00	0.250	6.00	0.13	0.75	0.09	0.03
Stiffs - Upper Flg			2.04	1.3	2.652	3.4476	
iffener Web	78.00	0.500	39.00	39.25	1530.75	60082	19773
Stiffs - lower flg			10.2	77	785.4	60475.8	
ower Flange	78.00	0.250	19.50	78.38	1528.31	119781	0.10
Σ =			76.74		3847.86	240343	19773
			260.9 lb/ft				

Summary properties :

			fb	Fb
D - Overall Depth	**78.50**	in		
Y_{FLG} - dist. to Neutral Axis from upper flange	**50.14**	in		
Y_{PL} - dist. to Neutral Axis from lower flange	**28.36**	in		
I_{YY} - Moment of Inertia y-y (parallel to deck)	**67,178**	in^4		
Z_{FLG} - Section Modulus Upper Flange	**1,340**	in^3	**39,520**	60,000

Z_{PL} - *Section Modulus Lower Flange*	**2,369**	in^3	**22,351**	22,800
A - Axial Area	**76.74**	in^2	b/t=(78/6)/.25=52	
V_S - *Shear Area*	**51.24**	in^2		
I_{ZZ} - *Moment of Inertia z-z (normal to deck)*	**9,886.50**	in^4		
r_{YY} - *radius of gyration*	**29.59**	in		
r_{ZZ} - *radius of gyration*	**#DIV/0!**	in		

Traveling Boom Crane



Boom length = 130 ft	**130** ft	**Total Boom Weight =**	**49,775** **pounds**

Boom will be analyzed as a compression boom. It is assumed that the boom will be in compression from the payload. It is also assumed that the deadweight of the boom will act as a beam in bending simply supported at the pedestal and tip

The moments in the boom will be calculated at the Pedestal, 0.2l, 0.4l and 0.7l

Weight of crane boom = w (lb/ft) Assumed to vary linearly along length of boom

Assume boom weighs **500** lb/ft at pedestal and **500** lb/ft at tip

P = Payload weight + Spreader Assembly weight = 80,000 lbs + 10,000 lbs = **90,000** lbs

S = Slew ring weight + associated machinery and drives + foundation structure

= 15,000 lbs + 4(5000 lbs) + 40% of this total for foundation structure = **-** lbs

For ice load calculation the following boom dimensions are assumed:

Ice load = **7** psf

Height of inner boom =	**6**	ft	Height of outer boom =	**5**	ft
Breadth of inner boom =	**6**	ft	Breadth of outer boom =	**5**	ft
Length of inner boom =	**52**	ft	Length of outer boom =	**78**	ft

Area of boom for ice load calculations =

24	ft**2/ft of inner boom =	**168**	lb/ft of inner boom
20	ft**2/ft of outer boom =	**140**	lb/ft of outer boom

Moment in boom at Pedestal due to ice only = Mice = 327,297 ft-lbs

For moment calculation in boom due to deadweight and machinery:

For input to moment calculation w = : 500 lb/ft and W = - lbs

Moment in Boom at Pedestal due to deadwt and mchnry only = Mdeadwt =

Mdeadwt = 1,056,250 ft-lbs

The total moment acting in the boom at the pedestal = Mtot = 1,383,547 ft-lbs

Assume high strength steel Fy = 100 ksi

The allowable stress will be taken as 60% of Fy = 60 ksi 60 ksi

The required section modulus in the boom at the pedestal = 276.7 in**3

MOMENT CALCULATION AT 0.2l x = 26 ft

Reaction at simple support due to constant load = - lbs

Moment @ 0.2l due to ice is taken to be the same as pedestal:

327,297 ft-lbs

Moment @ 0.2l due to deadweight and machinery:

676,000 ft-lbs

Total Moment @ 0.2l: 1,003,297 ft-lbs

Section modulus required @ 0.2l: 200.7 in**3 Assuming 100 ksi steel

MOMENT CALCULATION AT 0.4l x= 52 ft

Reaction at simple support due to constant load = - lbs

Moment @ 0.4l due to ice is taken to be the same as pedestal:

327,297 ft-lbs

Moment @ 0.4l due to deadweight and machinery:

	1,014,000	ft-lbs	
Total moment at 0.4l:	1,341,297	ft-lbs	
Section modulus required @ 0.4l:	268.3	in**3	Assuming 100 ksi steel

MOMENT CALCULATION AT 0.7l

x= 91 ft

Reaction at simple support due to constant load = -

Moment @ 0.7l due to ice is taken to be the same as pedestal:

	327,297	ft-lbs

Moment @ 0.7l due to deadweight and machinery:

	887,250	ft-lbs
Total moment @ 0.7l:	1,214,547	ft-lbs
Section modulus required @ 0.7l:	242.9	in**3

SUMMARY

LOCATION	Smreqd	1.1x SMreqd
Pedestal	276.7	304.4
0.2l	200.7	220.7
0.4l	268.3	295.1
0.7l	242.9	267.2

The axial load in the boom is based on a 15 degree angle between the boom and the support cables. This results in a compressive load in the boom of approximately 340,000 pounds which needs to be increased by 35% to account for ship motion.

Axial load =	340,000	pounds	459,000	pounds including the effects of ship's motion

COMPRESSION BOOM PROPERTY CALCULATION

SECTION PROPERTY CALCULATIONS FOR CRANE BOOM

SECTION FROM PEDESTAL TO 0.2L			Minimum SM Reqd =		**304.4**	in3	
			Moment @ Pedestal =		**1,383,547**	ft-lbs	
	Breadth	Thickness	A (in^2)	y (in)	Ay (in^3)	Ay² (in^4)	I_O (in^4)
pper Flange	36.00	0.313	11.25	0.16	1.76	0.27	0.09
Stiffs - Upper Flg			0	1.3	0	0	
tiffener Web	60.00	1.250	75.00	30.31	2273.44	68914	22500
Stiffs - lower flg			0	58.7	0	0	
ower Flange	36.00	0.313	11.25	60.47	680.27	41135	0.09
Σ =			97.50		2955.47	110049	22500
			331.5	lb/ft			

Summary properties :

D - Overall Depth	**60.63** in	fb	Fb
Y_{FLG} - dist. to Neutral Axis from upper flange	**30.31** in		
Y_{PL} - dist. to Neutral Axis from lower flange	**30.31** in		
I_{YY} - Moment of Inertia y-y (parallel to deck)	**42,962** in^4		
Z_{FLG} - Section Modulus Upper Flange	**1,417** in^3	**12,886**	60,000
Z_{PL} - Section Modulus Lower Flange	**1,417** in^3	**12,886**	19,200
A - Axial Area	**97.50** in^2		
V_S - Shear Area	**75.00** in^2	b/t=(36/2)/.3125=57.6	
I_{ZZ} - Moment of Inertia z-z (normal to deck)	**5,468** in^4		
r_{YY} - radius of gyration	**20.99** in		
r_{ZZ} - radius of gyration	**7.49** in		

COMPRESSION BOOM PROPERTY CALCULATION

SECTION PROPERTY CALCULATIONS FOR CRANE BOOM

SECTION FROM 0.2L TO 0.4L Minimum SM Reqd = **220.7** in3

			Moment @ 0.2L =		**1,003,297**	ft-lbs	
	Breadth	Thickness	A (in^2)	y (in)	Ay (in^3)	Ay² (in^4)	I_O (in^4)
pper Flange	36.00	0.313	11.25	0.16	1.76	0.27	0.09
Stiffs - Upper Flg			0	1.3	0	0	
tiffener Web	60.00	1.250	75.00	30.31	2273.44	68914	22500
Stiffs - lower flg			0	56.7	0	0	
wer Flange	36.00	0.313	11.25	60.47	680.27	41135	0.09
Σ =			97.50		2955.47	110049	22500
			331.5	lb/ft			

Summary properties :

D - Overall Depth	**60.63** in	fb	Fb
Y_{FLG} - dist. to Neutral Axis from upper flange	**30.31** in		
Y_{PL} - dist. to Neutral Axis from lower flange	**30.31** in		
I_{YY} - Moment of Inertia y-y (parallel to deck)	**42,962** in^4		
Z_{FLG} - Section Modulus Upper Flange	**1,417** in^3	**9,344**	60,000
Z_{PL} - Section Modulus Lower Flange	**1,417** in^3	**9,344**	19,200
A - Axial Area	**97.50** in^2	b/t=(36/2)/.3125=57.6	
V_S - Shear Area	**75.00** in^2		
I_{ZZ} - Moment of Inertia z-z (normal to deck)	**1,215.00** in^4		
r_{YY} - radius of gyration	**20.99** in		
r_{ZZ} - radius of gyration	**#DIV/0!** in		

COMPRESSION BOOM PROPERTY CALCULATION

SECTION PROPERTY CALCULATIONS FOR CRANE BOOM

SECTION FROM 0.4L to 0.7L

			Minimum SM Reqd =		**295.1**	in3	
			Moment @ 0.4L =		**1,341,297**	ft-lbs	
	Breadth	Thickness	A (in^2)	y (in)	Ay (in^3)	Ay² (in^4)	I_O (in^4)
pper Flange	36.00	0.313	11.25	0.16	1.76	0.27	0.09
Stiffs - Upper Flg			0	1.3	0	0	
tiffener Web	60.00	1.250	75.00	30.31	2273.44	68914	22500

Stiffs - lower flg			0	58.7	0	0	
wer Flange	36.00	0.313	11.25	60.47	680.27	41135	0.09
Σ =			97.50		2955.47	110049	22500
			331.5	lb/ft			

Summary properties :

D - Overall Depth	**60.63**	in	fb	Fb
Y_{FLG} - dist. to Neutral Axis from upper flange	**30.31**	in		
Y_{PL} - dist. to Neutral Axis from lower flange	**30.31**	in		
I_{YY} - Moment of Inertia y-y (parallel to deck)	**42,962**	in^4		
Z_{FLG} - Section Modulus Upper Flange	**1,417**	in^3	**12,492**	60,000
Z_{PL} - Section Modulus Lower Flange	**1,417**	in^3	**12,492**	19,200
A - Axial Area	**97.50**	in^2	b/t=(36/2)/.3125=57.6	
V_S - Shear Area	**75.00**	in^2		
I_{ZZ} - Moment of Inertia z-z (normal to deck)	**1,215.00**	in^4		
r_{YY} - radius of gyration	**20.99**	in		
r_{ZZ} - radius of gyration	**#DIV/0!**	in		

COMPRESSION BOOM PROPERTY CALCULATION

SECTION PROPERTY CALCULATIONS FOR CRANE BOOM

SECTION FROM 0.7L to boom tip Minimum SM Reqd = **267.2** in3

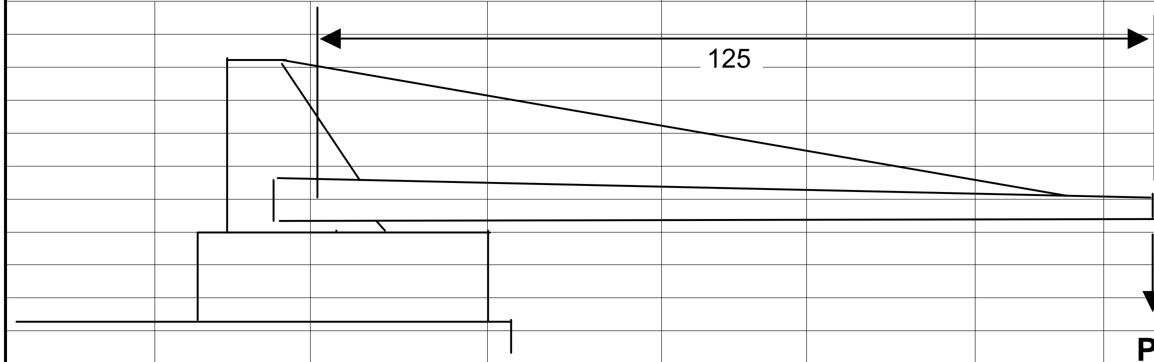
Moment @ 0.7L = **1,214,547** ft-lbs

	Breadth	Thickness	A (in^2)	y (in)	Ay (in^3)	Ay² (in^4)	I_O (in^4)
pper Flange	36.00	0.313	11.25	0.16	1.76	0.27	0.09
Stiffs - Upper Flg			0	1.3	0	0	
tiffener Web	60.00	1.250	75.00	30.31	2273.44	68914	22500
Stiffs - lower flg			0	58.7	0	0	
wer Flange	36.00	0.313	11.25	60.47	680.27	41135	0.09
Σ =			97.50		2955.47	110049	22500
			331.5	lb/ft			

Summary properties :

D - Overall Depth	**60.63**	in	fb	Fb
Y_{FLG} - dist. to Neutral Axis from upper flange	**30.31**	in		
Y_{PL} - dist. to Neutral Axis from lower flange	**30.31**	in		
I_{YY} - Moment of Inertia y-y (parallel to deck)	**42,962**	in^4		
Z_{FLG} - Section Modulus Upper Flange	**1,417**	in^3	**11,312**	60,000
Z_{PL} - Section Modulus Lower Flange	**1,417**	in^3	**11,312**	19,200
A - Axial Area	**97.50**	in^2	b/t=(36/2)/.3125=57.6	
V_S - Shear Area	**75.00**	in^2		
I_{ZZ} - Moment of Inertia z-z (normal to deck)	**1,215.00**	in^4		
r_{YY} - radius of gyration	**20.99**	in		
r_{ZZ} - radius of gyration	**#DIV/0!**	in		

Traveling Luffing Crane



Boom length = 125 ft		125	ft	**Total Boom Weight =**	47,860	**pounds**

Boom will be analyzed as a compression boom. It is assumed that the boom will be in compression from the payload. It is also assumed that the deadweight of the boom will act as a beam in bending simply supported at the pedestal and tip

The moments in the boom will be calculated at the Pedestal, 0.2l, 0.4l and 0.7l

Weight of crane boom = w (lb/ft) — Assumed to vary linearly along length of boom

Assume boom weighs 500 lb/ft at pedestal and 500 lb/ft at tip

P = Payload weight + Spreader Assembly weight = 80,000 lbs + 10,000 lbs = 90,000 lbs

S = Slew ring weight + associated machinery and drives + foundation structure
= 15,000 lbs + 4(5000 lbs) + 40% of this total for foundation structure = - lbs

For ice load calculation the following boom dimensions are assumed:

Ice load = 7 psf

Height of inner boom =	6	ft	Height of outer boom =	5	ft
Breadth of inner boom =	6	ft	Breadth of outer boom =	5	ft
Length of inner boom =	50	ft	Length of outer boom =	75	ft

Area of boom for ice load calculations =							
24	ft**2/ft of inner boom =		168	lb/ft of inner boom			
20	ft**2/ft of outer boom =		140	lb/ft of outer boom			
Moment in boom at Pedestal due to ice only = Mice =					302,604	ft-lbs	
For moment calculation in boom due to deadweight and machinery:							
For input to moment calculation w = :			500	lb/ft	and W =	-	lbs
Moment in Boom at Pedestal due to deadwt and mchnry only = Mdeadwt =							
	Mdeadwt =	976,563	ft-lbs				
The total moment acting in the boom at the pedestal = Mtot =					1,279,167	ft-lbs	
Assume high strength steel Fy =			100	ksi			
The allowable stress will be taken as 60% of Fy = 60 ksi					60	ksi	
The required section modulus in the boom at the pedestal =					255.8	in**3	
MOMENT CALCULATION AT 0.2l				x =	25	ft	
Reaction at simple support due to constant load =				-	lbs		
Moment @ 0.2l due to ice is taken to be the same as pedestal:							
		302,604	ft-lbs				
Moment @ 0.2l due to deadweight and machinery:							
		625,000	ft-lbs				

Total Moment @ 0.2l:		927,604	ft-lbs				
Section modulus required @ 0.2l:			185.5	in**3	Assuming 100 ksi steel		
MOMENT CALCULATION AT 0.4l				x=	50	ft	
Reaction at simple support due to constant load =				-	lbs		
Moment @ 0.4l due to ice is taken to be the same as pedestal:							
		302,604	ft-lbs				
Moment @ 0.4l due to deadweight and machinery:							
		937,500	ft-lbs				
Total moment at 0.4l:		1,240,104	ft-lbs				
Section modulus required @ 0.4l:			248.0	in**3	Assuming 100 ksi steel		
MOMENT CALCULATION AT 0.7l				x=	87.5	ft	
Reaction at simple support due to constant load =				-			
Moment @ 0.7l due to ice is taken to be the same as pedestal:							
		302,604	ft-lbs				
Moment @ 0.7l due to deadweight and machinery:							
		820,313	ft-lbs				
Total moment @ 0.7l:		1,122,917	ft-lbs				
Section modulus required @ 0.7l:			224.6	in**3			

SUMMARY

LOCATION	Smreqd	1.1x SMreqd	
Pedestal	**255.8**	281.4	
0.2l	**185.5**	204.1	
0.4l	**248.0**	272.8	
0.7l	**224.6**	247.0	

The axial load in the boom is based on a 15 degree angle between the boom and the support cables. This results in a compressive load in the boom of approximately 340,000 pounds which needs to be increased by 35% to account for ship motion.

Axial load = **340,000** pounds **459,000** pounds including the effects of ship's motion

COMPRESSION BOOM PROPERTY CALCULATION

SECTION PROPERTY CALCULATIONS FOR CRANE BOOM

SECTION FROM PEDESTAL TO 0.2L Minimum SM Reqd = **281.4** in3

Moment @ Pedestal = **1,279,167** ft-lbs

	Breadth	Thickness	A (in^2)	y (in)	Ay (in^3)	Ay² (in^4)	I_O (in^4)
pper Flange	36.00	0.313	11.25	0.16	1.76	0.27	0.09
Stiffs - Upper Flg			0	1.3	0	0	
iffener Web	60.00	1.250	75.00	30.31	2273.44	68914	22500
Stiffs - lower flg			0	58.7	0	0	
wer Flange	36.00	0.313	11.25	60.47	680.27	41135	0.09
Σ =			97.50		2955.47	110049	22500
			331.5	lb/ft			

Summary properties :					
D - Overall Depth	**60.63**	in	fb	Fb	
Y_{FLG} - dist. to Neutral Axis from upper flange	**30.31**	in			
Y_{PL} - dist. to Neutral Axis from lower flange	**30.31**	in			
I_{YY} - Moment of Inertia y-y (parallel to deck)	**42,962**	in^4			
Z_{FLG} - Section Modulus Upper Flange	**1,417**	in^3	**11,914**	60,000	
Z_{PL} - Section Modulus Lower Flange	**1,417**	in^3	**11,914**	19,200	
A - Axial Area	**97.50**	in^2			
V_S - Shear Area	**75.00**	in^2	b/t=(36/2)/.3125=57.6		
I_{ZZ} - Moment of Inertia z-z (normal to deck)	**5,468**	in^4			
r_{YY} - radius of gyration	**20.99**	in			
r_{ZZ} - radius of gyration	**7.49**	in			

COMPRESSION BOOM PROPERTY CALCULATION

SECTION PROPERTY CALCULATIONS FOR CRANE BOOM

SECTION FROM 0.2L TO 0.4L — Minimum SM Reqd = **204.1** in3

Moment @ 0.2L = **927,604** ft-lbs

	Breadth	Thickness	A (in^2)	y (in)	Ay (in^3)	Ay² (in^4)	I_O (in^4)
pper Flange	36.00	0.313	11.25	0.16	1.76	0.27	0.09
Stiffs - Upper Flg			0	1.3	0	0	
tiffener Web	60.00	1.250	75.00	30.31	2273.44	68914	22500
Stiffs - lower flg			0	56.7	0	0	
wer Flange	36.00	0.313	11.25	60.47	680.27	41135	0.09
Σ =			97.50		2955.47	110049	22500
			331.5	lb/ft			

Summary properties :

D - Overall Depth	**60.63**	in		fb	Fb
Y_{FLG} - dist. to Neutral Axis from upper flange	**30.31**	in			
Y_{PL} - dist. to Neutral Axis from lower flange	**30.31**	in			
I_{YY} - Moment of Inertia y-y (parallel to deck)	**42,962**	in^4			
Z_{FLG} - Section Modulus Upper Flange	**1,417**	in^3		**8,639**	60,000
Z_{PL} - Section Modulus Lower Flange	**1,417**	in^3		**8,639**	19,200
A - Axial Area	**97.50**	in^2	b/t=(36/2)/.3125=57.6		
V_S - Shear Area	**75.00**	in^2			
I_{ZZ} - Moment of Inertia z-z (normal to deck)	**1,215.00**	in^4			
r_{YY} - radius of gyration	**20.99**	in			
r_{ZZ} - radius of gyration	**#DIV/0!**	in			

COMPRESSION BOOM PROPERTY CALCULATION

SECTION PROPERTY CALCULATIONS FOR CRANE BOOM

SECTION FROM 0.4L to 0.7L

Minimum SM Reqd =	**272.8**	in3
Moment @ 0.4L =	**1,240,104**	ft-lbs

	Breadth	Thickness	A (in^2)	y (in)	Ay (in^3)	Ay² (in^4)	I_O (in^4)
pper Flange	36.00	0.313	11.25	0.16	1.76	0.27	0.09
Stiffs - Upper Flg			0	1.3	0	0	
tiffener Web	60.00	1.250	75.00	30.31	2273.44	68914	22500
Stiffs - lower flg			0	58.7	0	0	
wer Flange	36.00	0.313	11.25	60.47	680.27	41135	0.09
Σ =			97.50		2955.47	110049	22500
			331.5	lb/ft			

Summary properties :

D - Overall Depth			**60.63**	in		fb	Fb
Y_{FLG} - dist. to Neutral Axis from upper flange			**30.31**	in			
Y_{PL} - dist. to Neutral Axis from lower flange			**30.31**	in			
I_{YY} - Moment of Inertia y-y (parallel to deck)			**42,962**	in^4			
Z_{FLG} - Section Modulus Upper Flange			**1,417**	in^3		**11,550**	60,000
Z_{PL} - Section Modulus Lower Flange			**1,417**	in^3		**11,550**	19,200
A - Axial Area			**97.50**	in^2		b/t=(36/2)/.3125=57.6	
V_S - Shear Area			**75.00**	in^2			
I_{ZZ} - Moment of Inertia z-z (normal to deck)			**1,215.00**	in^4			
r_{YY} - radius of gyration			**20.99**	in			
r_{ZZ} - radius of gyration			**#DIV/0!**	in			

COMPRESSION BOOM PROPERTY CALCULATION

SECTION PROPERTY CALCULATIONS FOR CRANE BOOM

SECTION FROM 0.7L to boom tip — Minimum SM Reqd = **247.0** in3

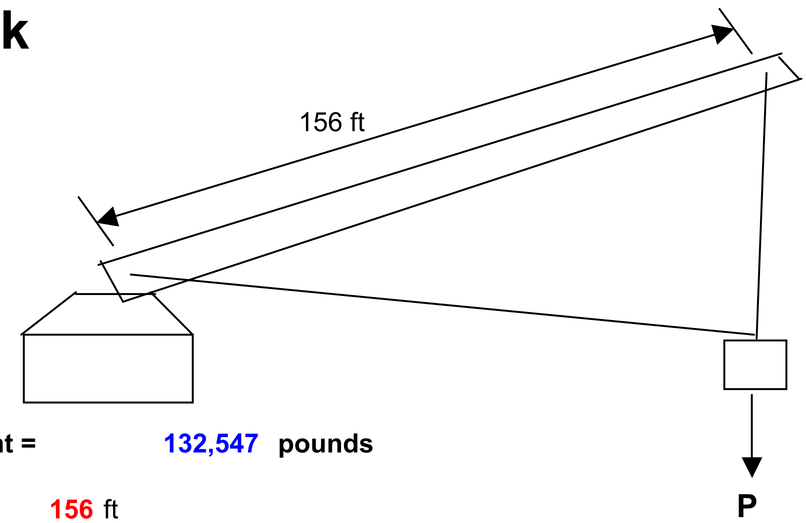
Moment @ 0.7L = **1,122,917** ft-lbs

	Breadth	Thickness	A (in^2)	y (in)	Ay (in^3)	Ay² (in^4)	I_O (in^4)
pper Flange	36.00	0.313	11.25	0.16	1.76	0.27	0.09
Stiffs - Upper Flg			0	1.3	0	0	
iffener Web	60.00	1.250	75.00	30.31	2273.44	68914	22500
Stiffs - lower flg			0	58.7	0	0	
wer Flange	36.00	0.313	11.25	60.47	680.27	41135	0.09
Σ =			97.50		2955.47	110049	22500
			331.5	lb/ft			

Summary properties :

D - Overall Depth	**60.63**	in	fb	Fb
Y_{FLG} - dist. to Neutral Axis from upper flange	**30.31**	in		
Y_{PL} - dist. to Neutral Axis from lower flange	**30.31**	in		
I_{YY} - Moment of Inertia y-y (parallel to deck)	**42,962**	in^4		
Z_{FLG} - Section Modulus Upper Flange	**1,417**	in^3	**10,458**	60,000
Z_{PL} - Section Modulus Lower Flange	**1,417**	in^3	**10,458**	19,200
A - Axial Area	**97.50**	in^2	b/t=(36/2)/.3125=57.6	
V_S - Shear Area	**75.00**	in^2		
I_{ZZ} - Moment of Inertia z-z (normal to deck)	**1,215.00**	in^4		
r_{YY} - radius of gyration	**20.99**	in		
r_{ZZ} - radius of gyration	**#DIV/0!**	in		

A - Frame Track



Total Boom Weight = 132,547 pounds

Boom length = 156 ft 156 ft

Boom of crane needs to support bending moment and shear from its own weight, payload, and internal operating hardware.

The moments in the boom will be calculated at the Pedestal, 0.2l, 0.4l and 0.7l

Weight of crane boom = w (lb/ft) Assumed to vary linearly along length of boom

Assume boom weighs 550 lb/ft at pedestal and 400 lb/ft at tip

P = Payload weight + Spreader Assembly weight = 80,000 lbs + 10,000 lbs = 90,000 lbs
Assume 2/3 of 90,000 pound payload acts into each leg of boom for design 60,000 lbs

For ice load calculation the following boom dimensions are assumed:

Ice load = 7 psf

Height of boom @ ped = 6 ft Height of boom @ tip= 5 ft
Breadth of boom @ ped= 6 ft Breadth of boom @ tip= 5 ft

Area of boom for ice load calculations =

24 ft**2/ft of inner boom = 168 lb/ft of inner boom
20 ft**2/ft of outer boom = 140 lb/ft of outer boom

Wice = 2184 lbs

Moment in boom at Pedestal due to ice only = Mice = 1,817,088 ft-lbs

For moment calculation in boom due to deadweight and machinery:

For input to moment calculation w = : 400 lb/ft and Wboom = 11,700 lbs

Moment in Boom at Pedestal due to deadwt and mchnry only = Mdeadwt =

Mdeadwt = 14,835,600 ft-lbs

The total moment acting in the boom at the pedestal = Mtot = 16,652,688 ft-lbs

Assume high strength steel Fy = 100 ksi
The allowable stress will be taken as 60% of Fy = 60 ksi 60 ksi

The required section modulus in the boom at the pedestal = 3330.5 in**3

MOMENT CALCULATION AT 0.2l

0.2l = 31.2 ft 0.8 = 124.8 ft

Moment @ 0.2l due to ice:
1,148,400 ft-lbs

Moment @ 0.2l due to deadweight and machinery:

10,914,509 ft-lbs

Total Moment @ 0.2l: 12,062,908 ft-lbs

Section modulus required @ 0.2l: 2412.6 in**3 Assuming 100 ksi steel

MOMENT CALCULATION AT 0.4l

0.4l= 62.4 ft 0.6l = 93.6 ft

Moment @ 0.4l due to ice:
637,798 ft-lbs

Moment @ 0.4l due to deadweight and machinery:

7,499,606 ft-lbs

Total moment at 0.4l: 8,137,404 ft-lbs

Section modulus required @ 0.4l: 1627.5 in**3 Assuming 100 ksi steel

MOMENT CALCULATION AT 0.7l

0.7l = 109.2 ft 0.3l = 46.8 ft

Moment @ 0.7l due to ice:
156,383 ft-lbs

Moment @ 0.4l due to deadweight and machinery:

3,262,475 ft-lbs

Total moment @ 0.7l: 3,418,858 ft-lbs

Section modulus required @ 0.7l: 683.8 in**3

SUMMARY

LOCATION	Smreqd	1.1x Smreqd
Pedestal	**3330.5**	3663.6
0.2l	**2412.6**	2653.8
0.4l	**1627.5**	1790.2
0.7l	**683.8**	752.1

A-FRAME CRANE

SECTION PROPERTY CALCULATIONS FOR CRANE BOOM

SECTION FROM PEDESTAL TO 0.2L Minimum SM Reqd = **3663.6** in3

Moment @ Pedestal = **16,652,688** ft-lbs

	Breadth	Thickness	A (in^2)	y (in)	Ay (in^3)	Ay^2 (in^4)	I_O (in^4)
pper Flange	84.00	0.438	36.75	0.22	8.04	1.76	0.59
Stiffs - Upper Flg			10.2	1.3	13.26	17.238	
iffener Web	84.00	0.875	73.50	42.44	3119.16	132369	43218
Stiffs - lower flg			10.2	82.7	843.54	69760.76	
ower Flange	84.00	0.438	36.75	84.66	3111.12	263376	0.59
Σ =			167.40		7095.11	465524	43219
			569.2 lb/ft				

Summary properties :

			fb	Fb
D - Overall Depth	**84.88**	in		
Y_{FLG} - dist. to Neutral Axis from upper flange	**42.38**	in		
Y_{PL} - dist. to Neutral Axis from lower flange	**42.49**	in		
I_{YY} - Moment of Inertia y-y (parallel to deck)	**208,023**	in^4		
Z_{FLG} - Section Modulus Upper Flange	**4,908**	in^3	**44,787**	51,600
Z_{PL} - Section Modulus Lower Flange	**4,896**	in^3	**44,900**	51,600
A - Axial Area	**167.40**	in^2	b/t=(84/6)/.4375=32	
V_S - Shear Area	**93.90**	in^2		
I_{ZZ} - Moment of Inertia z-z (normal to deck)	**21,609.00**	in^4		
r_{YY} - radius of gyration	**35.25**	in		

r_{ZZ} - radius of gyration **#DIV/0!** in

A-FRAME CRANE

SECTION PROPERTY CALCULATIONS FOR CRANE BOOM

SECTION FROM 0.2L TO 0.4L Minimum SM Reqd = **2653.8** in3

Moment @ 0.2L = **12,062,908** ft-lbs

	Breadth	Thickness	A (in^2)	y (in)	Ay (in^3)	Ay² (in^4)	I_O (in^4)
pper Flange	84.00	0.375	31.50	0.19	5.91	1.11	0.37
Stiffs - Upper Flg			10.2	1.3	13.26	17.238	
iffener Web	84.00	0.750	63.00	42.38	2669.63	113125	37044
Stiffs - lower flg			10.2	82.7	843.54	69760.76	
wer Flange	84.00	0.375	31.50	84.56	2663.72	225251	0.37
Σ =			146.40		6196.05	408155	37045
			497.8 lb/ft				

Summary properties :

			fb	Fb
D - Overall Depth	**84.75**	in		
Y_{FLG} - dist. to Neutral Axis from upper flange	**42.32**	in		
Y_{PL} - dist. to Neutral Axis from lower flange	**42.43**	in		
I_{YY} - Moment of Inertia y-y (parallel to deck)	**182,966**	in^4		
Z_{FLG} - Section Modulus Upper Flange	**4,323**	in^3	**36,832**	45,600
Z_{PL} - Section Modulus Lower Flange	**4,312**	in^3	**36,923**	45,600
A - Axial Area	**146.40**	in^2	b/t=(84/6)/.375=37.3	
V_S - Shear Area	**83.40**	in^2		
I_{ZZ} - Moment of Inertia z-z (normal to deck)	**18,522.00**	in^4		
r_{YY} - radius of gyration	**35.35**	in		
r_{ZZ} - radius of gyration	**#DIV/0!**	in		

A-FRAME CRANE

SECTION PROPERTY CALCULATIONS FOR CRANE BOOM

SECTION FROM 0.4L to 0.7L Minimum SM Reqd = **1790.2** in3

Moment @ 0.4L = **8,137,404** ft-lbs

	Breadth	Thickness	A (in^2)	y (in)	Ay (in^3)	Ay² (in^4)	I_O (in^4)
pper Flange	78.00	0.313	24.38	0.16	3.81	0.60	0.20

Stiffs - Upper Flg			10.2	1.3	13.26	17.238	
:iffener Web	78.00	0.625	48.75	39.31	1916.48	75342	24716
Stiffs - lower flg			10.2	76.7	782.34	60005.48	
ɔwer Flange	78.00	0.313	24.38	78.47	1912.68	150085	0.20
Σ =			117.90		4628.57	285450	24717
			400.9 lb/ft				

Summary properties :

			fb	Fb
D - Overall Depth	**78.63**	in	fb	Fb
Y_{FLG} - dist. to Neutral Axis from upper flange	**39.26**	in		
Y_{PL} - dist. to Neutral Axis from lower flange	**39.37**	in		
I_{YY} - Moment of Inertia y-y (parallel to deck)	**128,457**	in^4		
Z_{FLG} - Section Modulus Upper Flange	**3,272**	in^3	**32,827**	36,000
Z_{PL} - Section Modulus Lower Flange	**3,263**	in^3	**32,918**	36,000
A - Axial Area	**117.90**	in^2	b/t=(78/6)/.375=35	
V_S - Shear Area	**69.15**	in^2		
I_{ZZ} - Moment of Inertia z-z (normal to deck)	**12,358.13**	in^4		
r_{YY} - radius of gyration	**33.01**	in		
r_{ZZ} - radius of gyration	**#DIV/0!**	in		

A-FRAME CRANE

SECTION PROPERTY CALCULATIONS FOR CRANE BOOM

SECTION FROM 0.7L to boom tip Minimum SM Reqd = **752.1** in3

Moment @ 0.7L = **3,418,858** ft-lbs

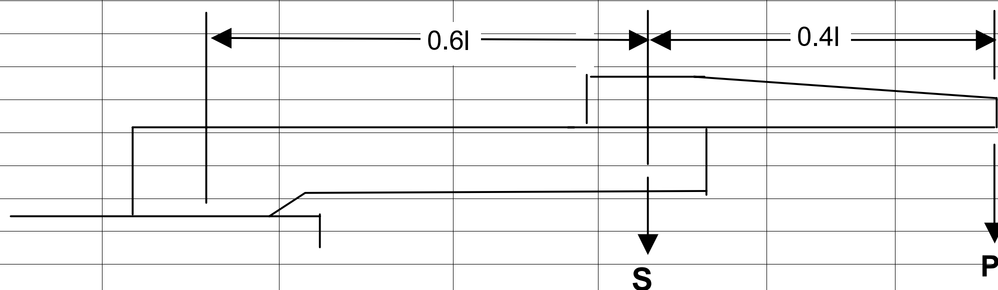
	Breadth	Thickness	A (in^2)	y (in)	Ay (in^3)	Ay² (in^4)	I_O (in^4)
ɔper Flange	69.00	0.250	17.25	0.13	2.16	0.27	0.09
Stiffs - Upper Flg			10.2	1.3	13.26	17.238	
:iffener Web	69.00	0.500	34.50	34.75	1198.88	41661	13688
Stiffs - lower flg			10.2	67.7	690.54	46749.56	
ɔwer Flange	69.00	0.250	17.25	69.38	1196.72	83022	0.09
Σ =			89.40		3101.55	171450	13688
			304.0 lb/ft				

Summary properties :

			fb	Fb
D - Overall Depth	**69.50**	in	fb	Fb
Y_{FLG} - dist. to Neutral Axis from upper flange	**34.69**	in		
Y_{PL} - dist. to Neutral Axis from lower flange	**34.81**	in		
I_{YY} - Moment of Inertia y-y (parallel to deck)	**77,536**	in^4		
Z_{FLG} - Section Modulus Upper Flange	**2,235**	in^3	**20,193**	28,800

Z_{PL} - *Section Modulus Lower Flange*	**2,228**	in^3	**20,259**	28,800
A - Axial Area	**89.40**	in^2	b/t=(69/6)/.25=46	
V_S - *Shear Area*	**54.90**	in^2		
I_{ZZ} - *Moment of Inertia z-z (normal to deck)*	**6,843.94**	in^4		
r_{YY} - *radius of gyration*	**29.45**	in		
r_{ZZ} - *radius of gyration*	**#DIV/0!**	in		

Double Arm 60/40 - 4 Fixed Pedestal Cranes



Boom length = 155 ft		155	ft	Total Boom Weight =		93,394	pounds

Boom of crane needs to support bending moment and shear from its own weight, payload, and internal operating hardware.

The moments in the boom will be calculated at the Pedestal, 0.3l, 0.6l and 0.8l

Weight of crane boom = w (lb/ft) — Assumed to vary linearly along length of boom

Assume boom weighs **1,000** lb/ft at pedestal and **500** lb/ft at tip

P = Payload weight + Spreader Assembly weight = 80,000 lbs + 10,000 lbs = **90,000** lbs

S = Slew ring weight + associated machinery and drives + foundation structure
= 15,000 lbs + 4(5000 lbs) + 100% of this total for foundation structure = **70,000** lbs

For ice load calculation the following boom dimensions are assumed:

Ice load = **7** psf

Height of inner boom =	10	ft	Height of outer boom =	7.5	ft
Breadth of inner boom =	10	ft	Breadth of outer boom =	7.5	ft
Length of inner boom =	93	ft	Length of outer boom =	62	ft

Area of boom for ice load calculations =

40	ft**2/ft of inner boom =	280	lb/ft of inner boom
30	ft**2/ft of outer boom =	210	lb/ft of outer boom

Moment in boom at Pedestal due to ice only = Mice =					2,802,917	ft-lbs	
For moment calculation in boom due to deadweight and machinery:							
For input to moment calculation w = :			500	lb/ft	and W =	38,750	lbs
Moment in Boom at Pedestal due to deadwt and mchnry only = Mdeadwt =							
	Mdeadwt =	28,468,333	ft-lbs				
The total moment acting in the boom at the pedestal = Mtot =					31,271,250	ft-lbs	
Assume high strength steel Fy =			100	ksi			
The allowable stress will be taken as 60% of Fy = 60 ksi					60	ksi	
The required section modulus in the boom at the pedestal =					6254.3	in**3	
MOMENT CALCULATION AT 0.3l							
0.3l =	46.5	ft	0.7l =	108.5	ft		
Moment @ 0.3l due to ice:							
		1,311,765	ft-lbs				
Moment @ 0.3l due to deadweight and machinery:							
		16,649,777	ft-lbs				
Total Moment @ 0.3l:		17,961,542	ft-lbs				
Section modulus required @ 0.3l:			3592.3	in**3	Assuming 100 ksi steel		
MOMENT CALCULATION AT 0.6l							
0.6l=	93	ft	0.4l =	62	ft		

Moment @ 0.6l due to ice:							
		403,620	ft-lbs				
Moment @ 0.6l due to deadweight and machinery:							
		6,669,133	ft-lbs				
Total moment at 0.6l:		7,072,753	ft-lbs				
Section modulus required @ 0.6l:			1414.6	in**3	Assuming 100 ksi steel		

MOMENT CALCULATION AT 0.8l

0.8l =	124	ft	0.2l =	31	ft		
Moment @ 0.8l due to ice:							
		100,905	ft-lbs				
Moment @ 0.8l due to deadweight and machinery:							
		3,046,267	ft-lbs				
Total moment @ 0.8l:		3,147,172	ft-lbs				
Section modulus required @ 0.8l:			629.4	in**3			

SUMMARY

		LOCATION	Smreqd	1.1x SMreqd			
		Pedestal	6254.3	6879.7			
		0.3l	3592.3	3951.5			
		0.6l	1414.6	1556.0			
		0.8l	629.4	692.4			

Outboard Arm Rotated 90 Degrees

The following section of calculations will determine the boom strength requirements with the outboard arm rotated 90 degrees.

This is only critical for the inboard arm and base reactions - there is no change to the requirements on the outboard arm.

This calculation assumes that the outboard arm will impart a moment and a reaction to the outer end of the inboard arm. The moment and reaction will be the result of ice loads, structural deadweight, container payload and spreader assembly.

Ice load on outer boom =			210	lbs/ft =	19,530	lbs
and a moment of		403,620	ft-lbs at the outer end of inner arm			
Payload & spreader assembly =			90,000	lbs		
and a moment of		5,580,000	ft-lbs at the outer end of the inner arm			
Structural deadweight of outer arm =			700	lbs/ft at inner end		
			500	lbs/ft at outer end		
			37,200	lbs		
	and a moment of		1,089,133			
Total reaction @ outer end of inner arm due to outer arm:					146,730	lbs
		with a torsional moment of:			7,072,753	ft-lbs
Moment at Pedestal due to outer arm reactions:					13,645,890	ft-lbs
		plus torsional moment of:			7,072,753	ft-lbs
Moment @ Pedestal due to ice load on inner arm:					1,210,860	ft-lbs
Moment @ Pedestal due to slew ring components:					6,510,000	ft-lbs
Structural deadweight of inner arm:			1,000	lbs/ft at inner end		
			700	lbs/ft at outer end		
			79,050	lbs		
	and a moment of:		3,459,600	ft-lbs		

Moments to be resisted at Pedestal:		24,826,350	ft-lbs
	plus a torsional moment of	7,072,753	ft-lbs

60/40 DOUBLE ARM CRANE - PEDESTAL BASE

SECTION PROPERTY CALCULATIONS FOR CRANE BOOM

SECTION FROM PEDESTAL TO 0.3L	Minimum SM Reqd =	**6879.7**	in3
	Moment @ Pedestal =	**31,271,250**	ft-lbs

	Breadth	Thickness	A (in^2)	y (in)	Ay (in^3)	Ay² (in^4)	I_O (in^4)
pper Flange	120.00	0.375	45.00	0.19	8.44	1.58	0.53
Stiffs - Upper Flg			14.28	1.3	18.564	24.1332	
tiffener Web	120.00	0.875	105.00	60.38	6339.38	382740	126000
Stiffs - lower flg			14.28	119	1699.32	202219.1	
ower Flange	120.00	0.438	52.50	120.59	6331.17	763500	0.84
Σ =			231.06		14396.87	1348484	126001
			785.6	lb/ft			

Summary properties :

D - Overall Depth	**120.81**	in	fb	Fb
Y_{FLG} - dist. to Neutral Axis from upper flange	**62.31**	in		
Y_{PL} - dist. to Neutral Axis from lower flange	**58.50**	in		
I_{YY} - Moment of Inertia y-y (parallel to deck)	**577,447**	in^4		
Z_{FLG} - Section Modulus Upper Flange	**9,268**	in^3	**44,540**	60,000
Z_{PL} - Section Modulus Lower Flange	**9,870**	in^3	**41,821**	49,200
A - Axial Area	**231.06**	in^2	b/t=(120/8)/.4375=34.2	
V_S - Shear Area	**133.56**	in^2		
I_{ZZ} - Moment of Inertia z-z (normal to deck)	**63,000.00**	in^4		
r_{YY} - radius of gyration	**49.99**	in		
r_{ZZ} - radius of gyration	**#DIV/0!**	in		

60/40 DOUBLE ARM CRANE - PEDESTAL BASE

SECTION PROPERTY CALCULATIONS FOR CRANE BOOM

SECTION FROM 0.3L TO 0.6L — Minimum SM Reqd = **3951.5** in3

Moment @ 0.3L = **17,961,542** ft-lbs

	Breadth	Thickness	A (in^2)	y (in)	Ay (in^3)	Ay² (in^4)	I_O (in^4)
pper Flange	120.00	0.250	30.00	0.13	3.75	0.47	0.16
Stiffs - Upper Flg			14.28	1.3	18.564	24.1332	
tiffener Web	120.00	0.750	90.00	60.25	5422.50	326706	108000
Stiffs - lower flg			14.28	119	1699.32	202219.1	
ower Flange	120.00	0.375	45.00	120.44	5419.69	652734	0.53
Σ =			193.56		12563.82	1181683	108001
			658.1	lb/ft			

Summary properties :

			fb	Fb
D - Overall Depth	**120.63**	in	fb	Fb
Y_{FLG} - dist. to Neutral Axis from upper flange	**64.91**	in		
Y_{PL} - dist. to Neutral Axis from lower flange	**55.72**	in		
I_{YY} - Moment of Inertia y-y (parallel to deck)	**474,176**	in^4		
Z_{FLG} - Section Modulus Upper Flange	**7,305**	in^3	**32,455**	60,000
Z_{PL} - Section Modulus Lower Flange	**8,511**	in^3	**27,858**	40,200
A - Axial Area	**193.56**	in^2	b/t=(120/8)/.375=40	
V_S - Shear Area	**118.56**	in^2		
I_{ZZ} - Moment of Inertia z-z (normal to deck)	**54,000.00**	in^4		
r_{YY} - radius of gyration	**49.50**	in		

r_{ZZ} - radius of gyration			**#DIV/0!**	in			

60/40 DOUBLE ARM CRANE - PEDESTAL BASE

SECTION PROPERTY CALCULATIONS FOR CRANE BOOM

SECTION FROM 0.6L to 0.8L

Minimum SM Reqd = **1556.0** in3

Moment @ 0.6L = **7,072,753** ft-lbs

	Breadth	Thickness	A (in^2)	y (in)	Ay (in^3)	Ay² (in^4)	I_O (in^4)
pper Flange	18.00	0.375	6.75	0.19	1.27	0.24	0.08
Stiffs - Upper Flg			0	1.3	0	0	
tiffener Web	90.00	0.625	56.25	45.38	2552.34	115813	37969
Stiffs - lower flg			10.2	89	907.8	80794.2	
ower Flange	90.00	0.375	33.75	90.56	3056.48	276803	0.40
Σ =			106.95		6517.89	473410	37969
			363.6	lb/ft			

Summary properties :

D - Overall Depth	**90.75**	in	fb	Fb
Y_{FLG} - dist. to Neutral Axis from upper flange	**60.94**	in		
Y_{PL} - dist. to Neutral Axis from lower flange	**29.81**	in		
I_{YY} - Moment of Inertia y-y (parallel to deck)	**114,157**	in^4		
Z_{FLG} - Section Modulus Upper Flange	**1,873**	in^3	**49,841**	60,000
Z_{PL} - Section Modulus Lower Flange	**3,830**	in^3	**24,377**	40,200
A - Axial Area	**106.95**	in^2	b/t=(90/6)/.375=40	
V_S - Shear Area	**66.45**	in^2		
I_{ZZ} - Moment of Inertia z-z (normal to deck)	**22,781.25**	in^4		
r_{YY} - radius of gyration	**32.67**	in		
r_{ZZ} - radius of gyration	**#DIV/0!**	in		

60/40 DOUBLE ARM CRANE - PEDESTAL BASE

SECTION PROPERTY CALCULATIONS FOR CRANE BOOM

SECTION FROM 0.8L to boom tip

Minimum SM Reqd = **692.4** in3

Moment @ 0.8L = **3,147,172** ft-lbs

	Breadth	Thickness	A (in^2)	y (in)	Ay (in^3)	Ay² (in^4)	I_O (in^4)
pper Flange	18.00	0.375	6.75	0.19	1.27	0.24	0.08
Stiffs - Upper Flg			0	1.3	0	0	
tiffener Web	90.00	0.500	45.00	45.38	2041.88	92650	30375
Stiffs - lower flg			10.2	89	907.8	80794.2	
wer Flange	90.00	0.250	22.50	90.50	2036.25	184281	0.12
Σ =			84.45		4987.19	357725	30375
			287.1	lb/ft			

Summary properties :

			fb	Fb
D - Overall Depth	**90.63**	in	fb	Fb
Y_{FLG} - dist. to Neutral Axis from upper flange	**59.05**	in		
Y_{PL} - dist. to Neutral Axis from lower flange	**31.57**	in		
I_{YY} - Moment of Inertia y-y (parallel to deck)	**93,582**	in^4		
Z_{FLG} - Section Modulus Upper Flange	**1,585**	in^3	**26,216**	60,000
Z_{PL} - Section Modulus Lower Flange	**2,964**	in^3	**14,014**	17,880
A - Axial Area	**84.45**	in^2	b/t=(90/6)/.25 = 60	
V_S - Shear Area	**55.20**	in^2		
I_{ZZ} - Moment of Inertia z-z (normal to deck)	**15,187.50**	in^4		
r_{YY} - radius of gyration	**33.29**	in		
r_{ZZ} - radius of gyration	**#DIV/0!**	in		