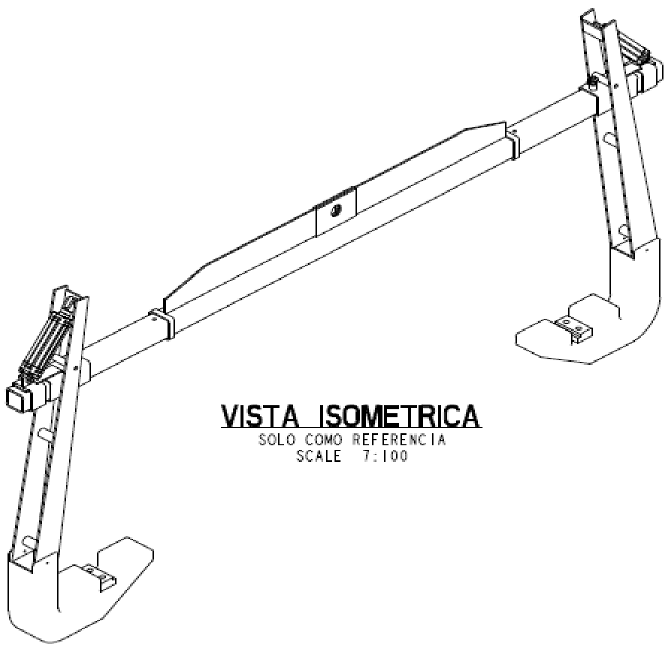
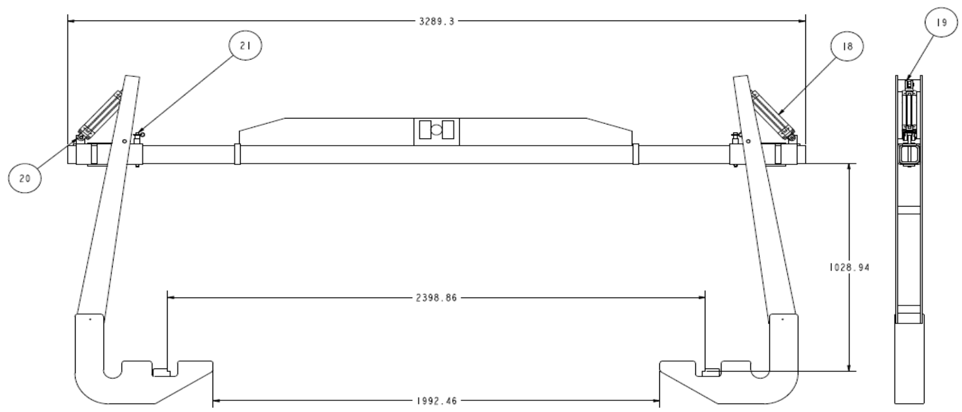
<table>
<tr><td>1</td><td>Structural Calculations for DL-123 (Lifting Device for PB-320 Cabinets)</td></tr>
<tr><td>2</td><td>Summary of Analysis: Lifting Device is rated for 1000 kg (2204 lbs), Service Class 3</td></tr>
<tr><td>3</td><td>
<table>
<tr><td colspan="2">CERTIFICACION</td></tr>
<tr><td colspan="2">DISPOSITIVO DE LEVANTE CABINAS PB-320</td></tr>
<tr><td>ALTA:</td><td></td></tr>
<tr><td>No. HERRAMIENTA:</td><td>DL-123</td></tr>
<tr><td>PESO:</td><td>178KG</td></tr>
<tr><td>CAPACIDAD:</td><td>1000KG</td></tr>
<tr><td>PRUEBA:</td><td>1250KG</td></tr>
<tr><td>LOCACION:</td><td>MONTAGE DE CABINAS</td></tr>
<tr><td>CATEGORIA</td><td>B</td></tr>
<tr><td>SERVICIO</td><td>3</td></tr>
</table>
</td></tr>
<tr><td>4</td><td>
</td></tr>
<tr><td>5</td><td>Basis of Analysis: The overall lifting device is analyzed using Solidworks simulation.</td></tr>
</table>

6	**Drawing of Lifting Device**		

7



CONJUNTO ARMADO
SCALE 9:100

8	Code Reference: ASME BTH-1-2017, Below the Hook Lifting Devices; issued March 15, 2017		
9	Service Class	3	Per Drawing

10

Table 2-3-1 Service Class

Service Class	Load Cycles
0	0–20,000
1	20,001–100,000
2	100,001–500,000
3	500,001–2,000,000
4	Over 2,000,000

11	Design Category	B	Lifters shall be designed to Design Category B, unless a qualified person determines that Design Category A is appropriate or that Design Category C is required for a special application.
12	Nominal Design Factor, N_d	3	Safety Factor for Static Strength Design
13	Nominal Design Factor, N_{dd}	3.6	The Safety Factor for Connections
14	Design Factor = the ratio of the limit state stress (es) or strength of an element to the permissible internal stress (es) or forces created by the external force (s) that act upon the element. (section 1-2).		

15

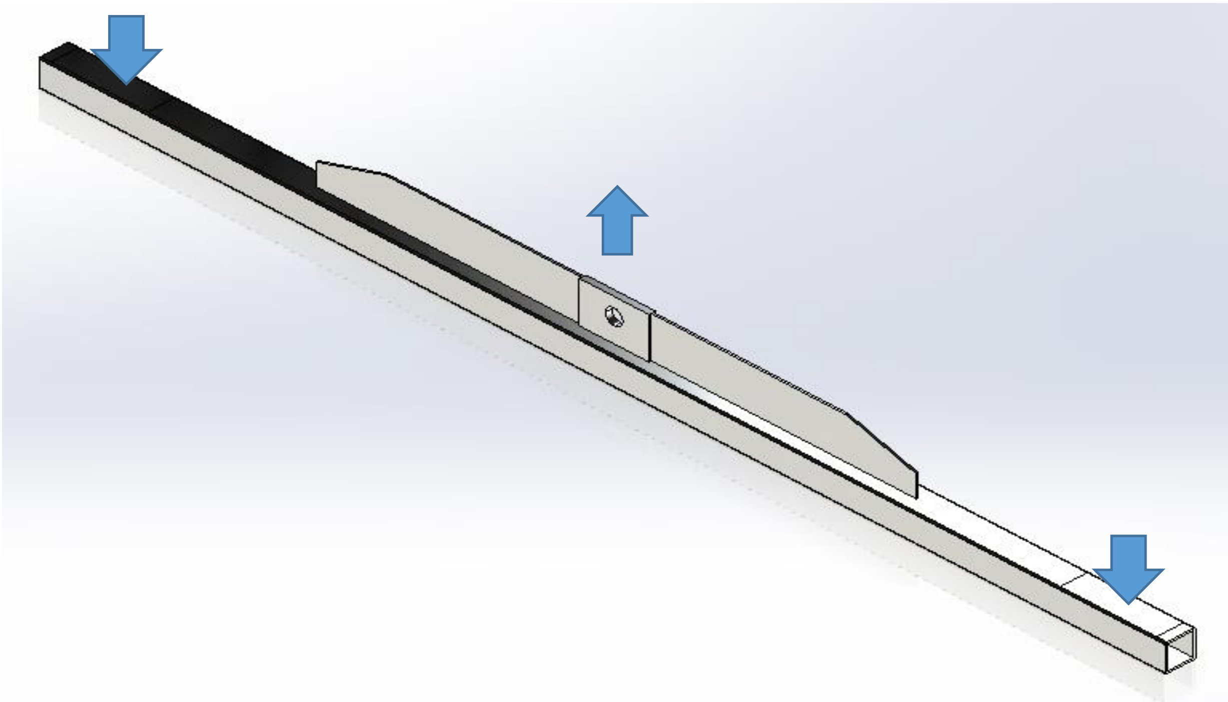
3-1.3 Static Design Basis

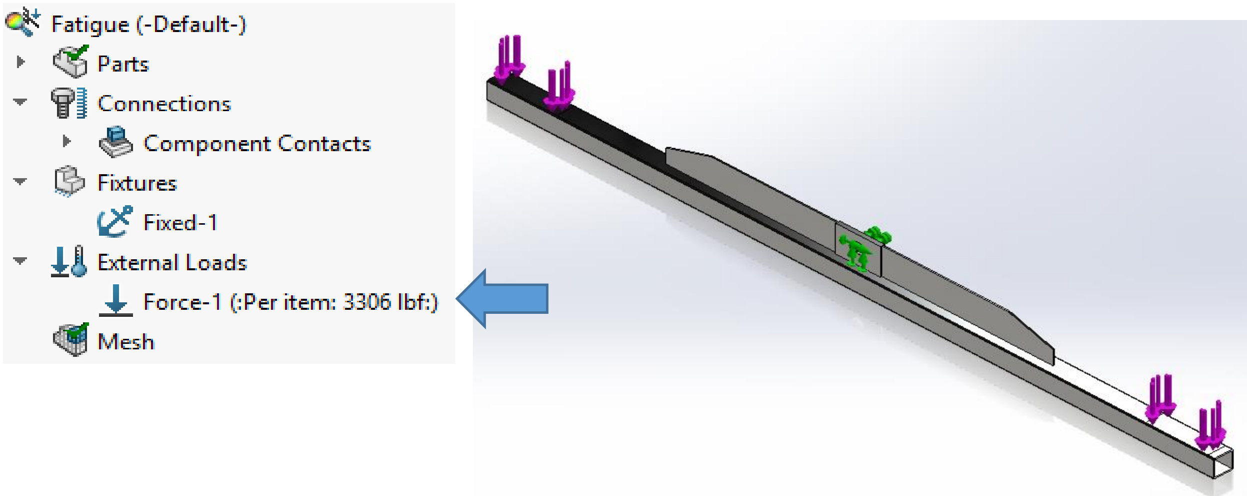
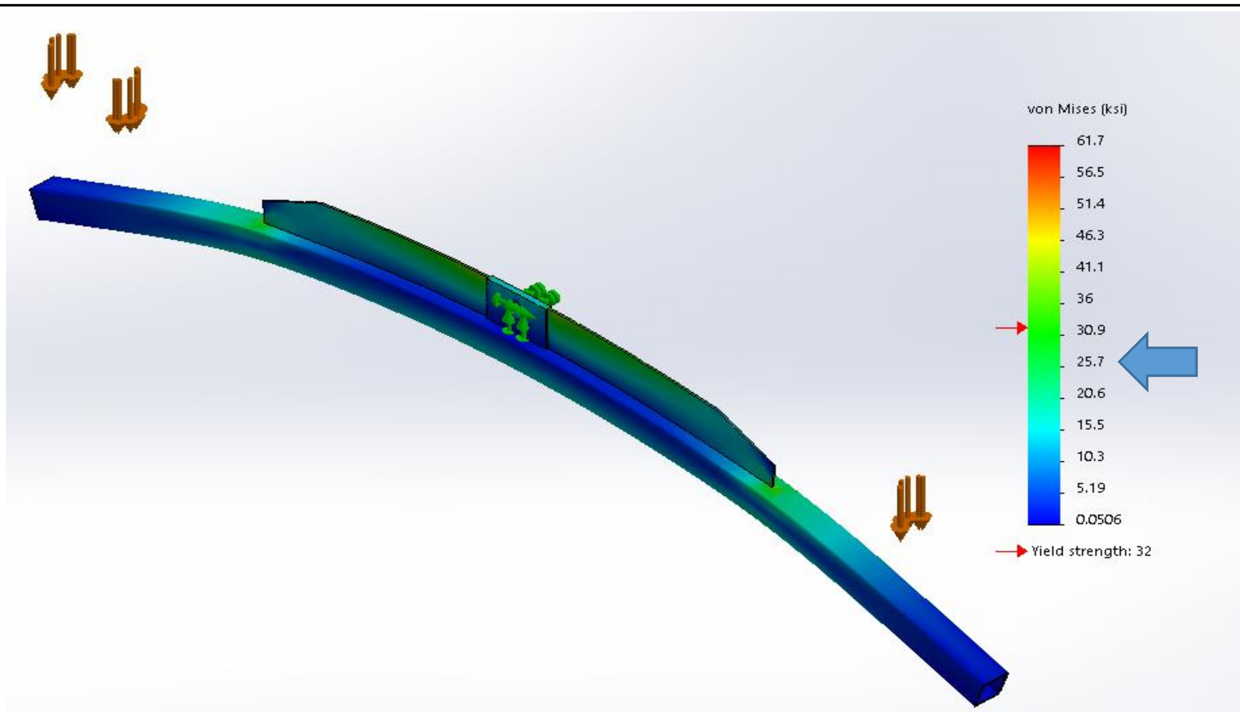
(17) **3-1.3.1 Nominal Design Factors.** The static strength design of a below-the-hook lifting device shall be based on the allowable stresses defined in sections 3-2 and 3-3. The minimum values of the nominal design factor, N_d, in the allowable stress equations shall be as follows:

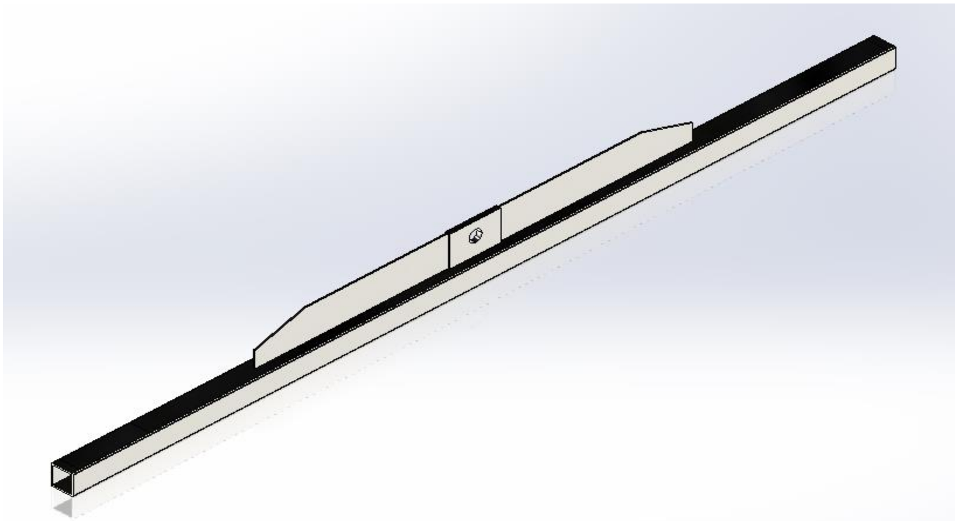
N_d = 2.00 for Design Category A lifters
= 3.00 for Design Category B lifters
= 6.00 for Design Category C lifters

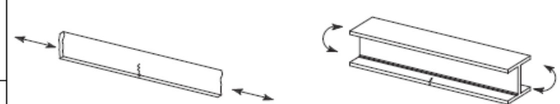
16

(b) Design factors for Design Category B lifting devices shall be not less than 3.00 for limit states of yielding or buckling and 3.60 for limit states of fracture and for connection design.

17	Job Load, J_{load} (kg)	1,000.0	Weight lifted by device (defined by client on drawings)
18	Job Load, J_{load} (lbs)	2,204.0	J_{load} x 2.2 lbs/kg
19	Using Solidworks, a model is created of the handling device		
20			
21	Rated Force on Upper Connection Point, F (lbs)	2,204.0	Job Load
22	Design factor, Df	3	For Structure
23	Applied Force, AF (lbs)	6,612.00	F x Df
24	Applied Force per Load Point Aft, (lbs)	3,306.00	AF/2

25	Apply the load to the Model using Solidworks Simulation		
26			
27	Run the Model		
28			
29	Max Von Mises Stress, Fm (ksi)	25.70	See above
30	Yield Strength of Material, Fy (ksi)	36.30	Mild Steel; assume A36 as worst case mild steel
31	Safety Factor	1.41	Fy/Fm = 1 OK

32	**Fatigue Analysis**		
33	Worst case is the top of the lifting device. (shown in solidworks simulation above). See Fatigue Stress Categories below (Ref. Table 3-4.4.1, ASME BTH-1-2017):		
34			
35			

Description	Stress Cate-gory	Constant, C_f	Threshold, F_{TH}, ksi (MPa)	Potential Crack Site Initiation	Illustrative Typical Examples
Section 1 — Plain Material Away From Any Welding					
1.1 Base metal, except noncoated weathering steel, with rolled or cleaned surface. Flame-cut edges with surface roughness value of 1,000 μin. (25 μm) or less, but without re-entrant corners.	A	250×10^8	24 (165)	Away from all welds or structural connections	 (a) (b)
1.2 Noncoated weathering steel base metal with rolled or cleaned surface. Flame-cut edges with surface roughness value of 1,000 μin. (25 μm) or less, but without re-entrant corners.	B	120×10^8	16 (110)	Away from all welds or structural connections	

36	Max Rated Load, W_{max} (lbs)	2,204.0	***Assumed loading 100% of time***
37	Max Rated Lift Point Load, W_{mc} (lbs)	1,102.00	$W_{max/2}$
38	Service Class	3	Per drawing
39			

Table 2-3-1 Service Class

Service Class	Load Cycles
0	0–20,000
1	20,001–100,000
2	100,001–500,000
3	500,001–2,000,000
4	Over 2,000,000

40	Allowable Stress Range, Fs (ksi)	18.0	Table 3-4.3-1, based on Service Class and worst case Stress Category for fatigue

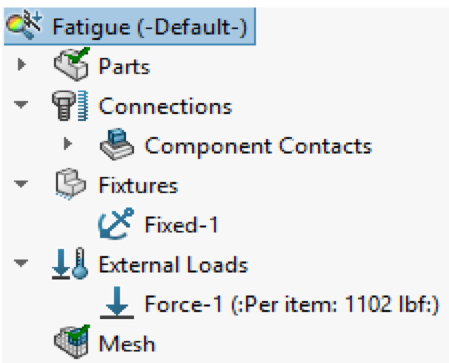
41

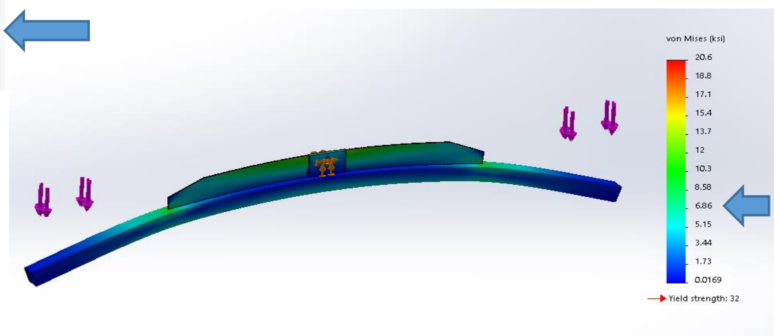
Table 3-4.3-1 Allowable Stress Ranges, ksi (MPa)

Stress Category (From Table 3-4.4-1)	Service Class 1	Service Class 2	Service Class 3	Service Class 4
A	63 (435)	37 (255)	24 (165)	24 (165)
B	49 (340)	29 (200)	18 (125)	16 (110)
B'	39 (270)	23 (160)	15 (100)	12 (80)
C	35 (240)	21 (145)	13 (90)	10 (70) [Note (1)]
D	28 (190)	16 (110)	10 (70)	7 (48)
E	22 (150)	13 (90)	8 (55)	5 (34)
E'	16 (110)	9 (60)	6 (40)	3 (20)
F	15 (100)	12 (80)	9 (60)	8 (55)
G	16 (110)	9 (60)	7 (48)	7 (48)

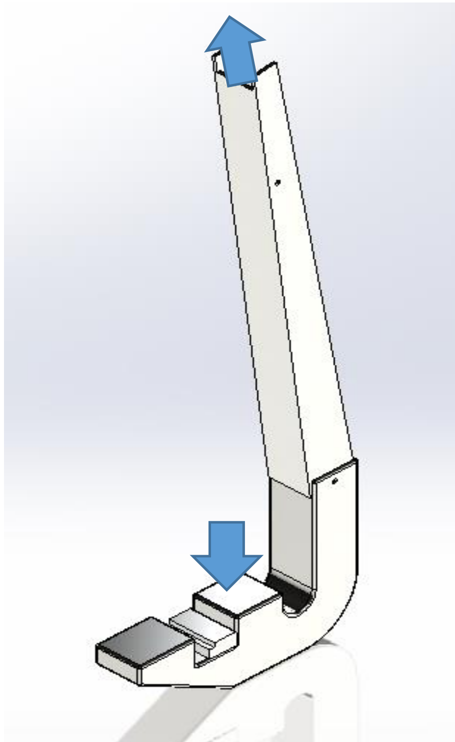
NOTE:
(1) Flexural stress range of 12 ksi (80 MPa) permitted at the toe of stiffener welds on flanges.

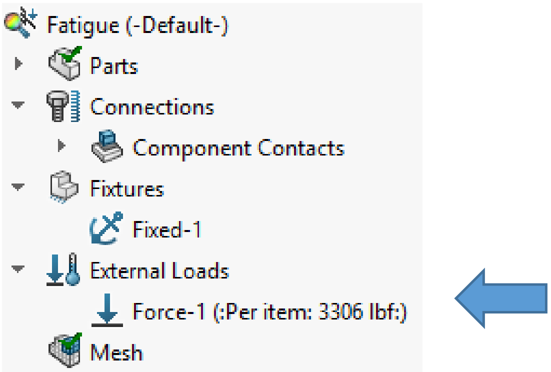
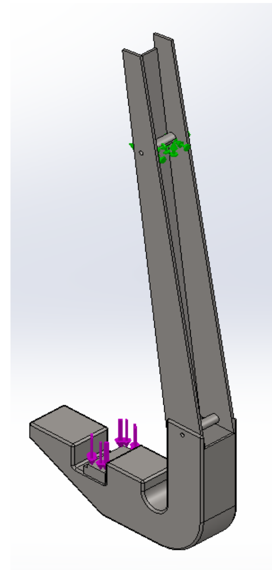
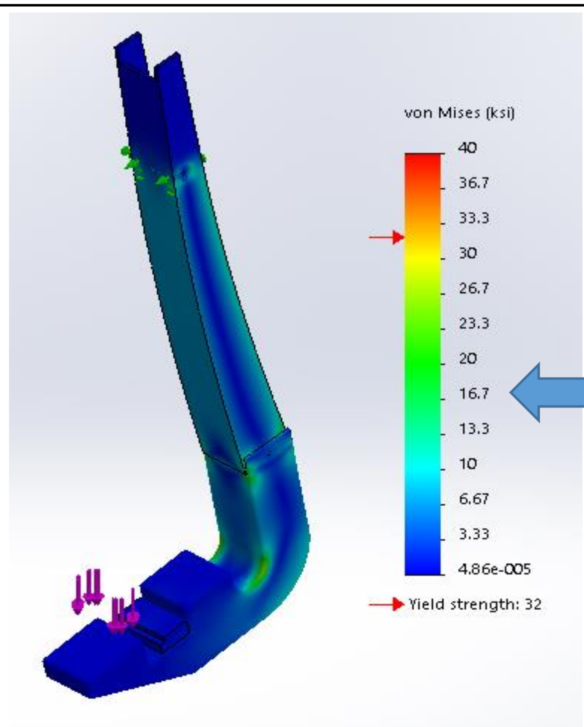
42

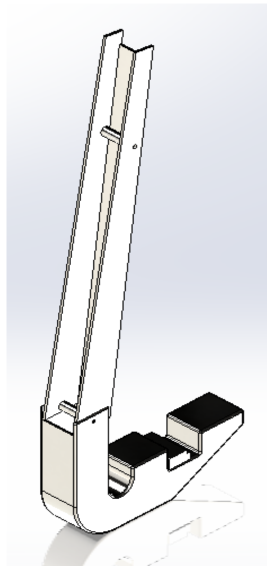




43	Actual Stress, F_a (ksi)	6.86	See above
44	Safety Factor	2.62	$F_s/F_a > 1$ OK

45	Analysis of detail 13-16		
46			
47	Rated Force on Upper Connection Point, F (lbs)	2,204.0	Job Load
48	Design factor, Df	3	For Structure
49	Applied Force, AF (lbs)	6,612.00	F x Df
50	Applied Force per Load Point Aft, (lbs)	3,306.00	AF/2

51	Apply the load to the Model using Solidworks Simulation		
52	 		
53	Run the Model		
54			
55	Max Von Mises Stress, Fm (ksi)	16.70	See above
56	Yield Strength of Material, Fy (ksi)	36.30	Mild Steel; assume A36 as worst case mild steel
57	Safety Factor	2.17	Fy/Fm = 1 OK

58	**Fatigue Analysis**		
59	Worst case is the top of the lifting device. (shown in solidworks simulation above). See Fatigue Stress Categories below (Ref. Table 3-4.4.1, ASME BTH-1-2017):		
60			

61

Description	Stress Category	Constant, C_f	Threshold, F_{TH}, ksi (MPa)	Potential Crack Site Initiation	Illustrative Typical Examples
Section 1 — Plain Material Away From Any Welding					
1.1 Base metal, except noncoated weathering steel, with rolled or cleaned surface. Flame-cut edges with surface roughness value of 1,000 μin. (25 μm) or less, but without re-entrant corners.	A	250×10^8	24 (165)	Away from all welds or structural connections	 (a) (b)
1.2 Noncoated weathering steel base metal with rolled or cleaned surface. Flame-cut edges with surface roughness value of 1,000 μin. (25 μm) or less, but without re-entrant corners.	B	120×10^8	16 (110)	Away from all welds or structural connections	

62	Max Rated Load, W_{max} (lbs)	2,204.0	***Assumed loading 100% of time***
63	Max Rated Lift Point Load, W_{mc} (lbs)	1,102.00	$W_{max/2}$
64	Service Class	3	Per drawing

65

Table 2-3-1 Service Class

Service Class	Load Cycles
0	0–20,000
1	20,001–100,000
2	100,001–500,000
3	500,001–2,000,000
4	Over 2,000,000

66	Allowable Stress Range, Fs (ksi)	18.0	Table 3-4.3-1, based on Service Class and worst case Stress Category for fatigue

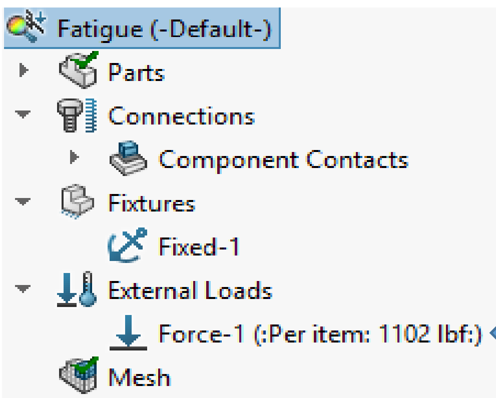
67

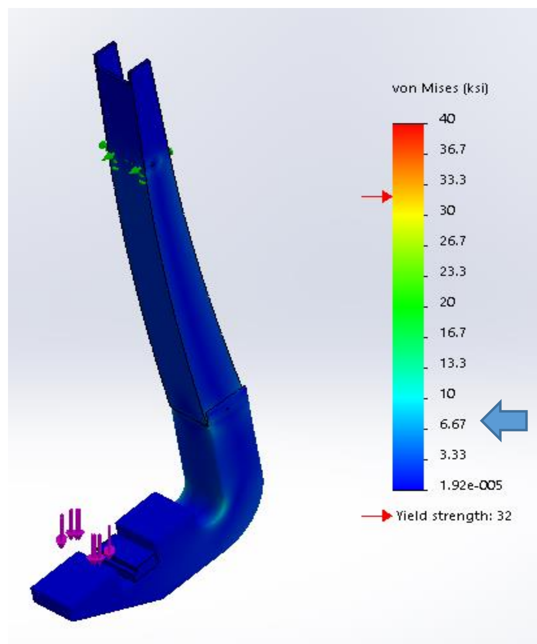
Table 3-4.3-1 Allowable Stress Ranges, ksi (MPa)

Stress Category (From Table 3-4.4-1)	Service Class 1	2	3	4
A	63 (435)	37 (255)	24 (165)	24 (165)
B	49 (340)	29 (200)	18 (125)	[illegible]
B'	39 (270)	23 (160)	15 (100)	12 (80)
C	35 (240)	21 (145)	13 (90)	10 (70) [Note (1)]
D	28 (190)	16 (110)	10 (70)	7 (48)
E	22 (150)	13 (90)	8 (55)	5 (34)
E'	16 (110)	9 (60)	6 (40)	3 (20)
F	15 (100)	12 (80)	9 (60)	8 (55)
G	16 (110)	9 (60)	7 (48)	7 (48)

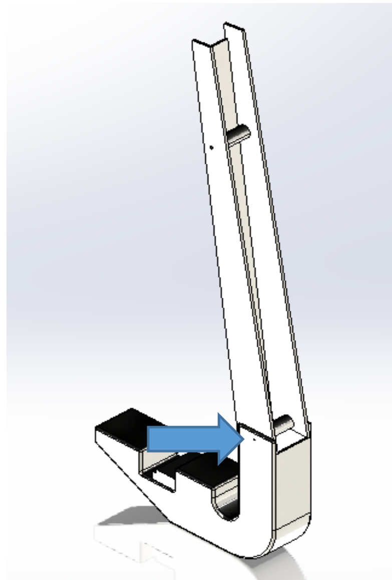
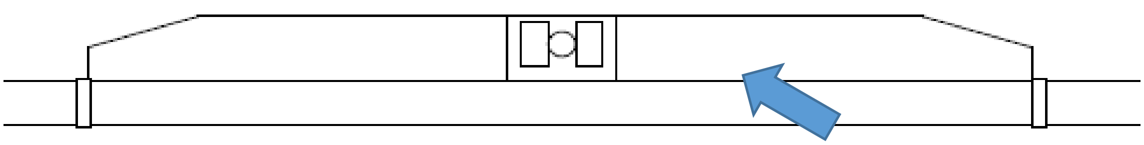
NOTE:
(1) Flexural stress range of 12 ksi (80 MPa) permitted at the toe of stiffener welds on flanges.

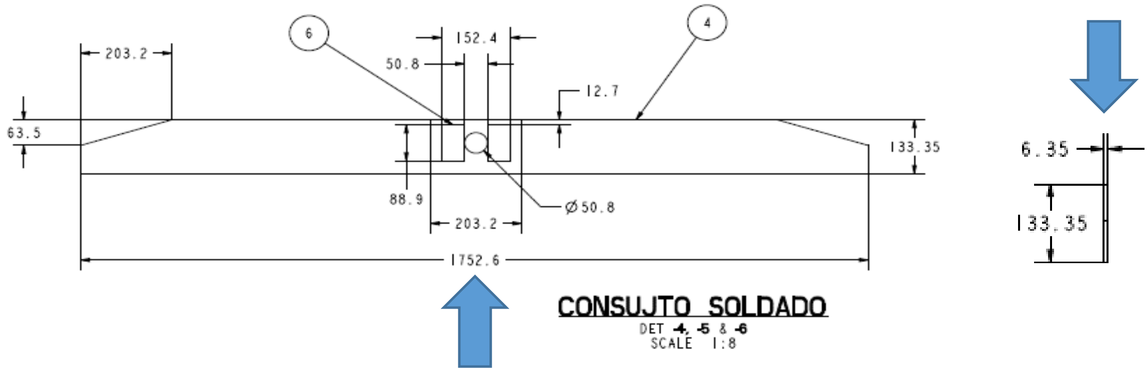
68





69	Actual Stress, F_a (ksi)	6.67	See above
70	Safety Factor	2.70	$F_s/F_a > 1$ OK

71	**Shear Analysis**		
72			
73	Max Rated Load, W_{max} (lbs)	2,204.0	***Assumed loading 100% of time***
74	Max Rated Lift Point Load, W_{mc} (lbs)	1,102.00	$W_{max}/2$
75	Surface Area, A (in²)	0.049	$A = \pi r^2 \times 2$
76	Shear stress, τ (psi)	22,449.76	$\tau = F/A$
77	Tensile Strength of Material, f_y (psi)	58,000.0	f_y
78	Shear Strength of Material, v (psi)	33,466.00	$0.577 \times f_y$
79	Shear Str. of Mat. > Shear Stress (psi)	33.5 > 22.5	$v > \tau$
80	**Connection Weld Analysis -Top Lift Tab**		
81			

82	*(b)* The design strength of fillet or partial-joint-penetration groove welds subject to shear shall be equal to the effective area of the weld multiplied by the allowable stress F_v given by eq. (3-55). Stresses in the base metal shall not exceed the limits defined in section 3-2. $F_v = \frac{0.60Exx}{1.20N_d}$ (3-55)		
83	Allowable Stress, F_v (ksi)	11.667	See above Eqn. 3-55
84	Nominal Tensile Strength of weld material, E_{xx} (ksi)	70	Typical Value
85	**Table 3-3.4.3-1 Minimum Sizes of Fillet Welds** Material Thickness of Thicker Part Joined, in. (mm) — Minimum Size of Fillet Weld, in. (mm) To 1/4 (6) — 1/8 (3) Over 1/4 (6) to 1/2 (13) — 3/16 (5) Over 1/2 (13) to 3/4 (19) — 1/4 (6) Over 3/4 (19) — 5/16 (8)		
86	Tensile Load, T_n (kips)	7	Iterative until safety factor met
87	Length of Tab, L (in)	69.00	See below
88	Thickness of Tab, t (in)	0.25	
89	Length of Fillet Weld, L (in)	138.50	L x 2 + t x 2
90			
91	Weld Leg, W_{leg} (in)	0.13	Refer to Table 3-3.4.3-1
92	Nominal Stress on Weld, F_n (ksi)	0.57	See below eqn (area of weld = length x effective throat thickness)
93	**Load** — **Rated stress** [MPa, psi] Tensile/Press. — $\sigma_\perp = \frac{F_n}{A_w} = \frac{F_n}{L \cdot a}$ a = .707 x Wl		
94	Safety Factor	20.40	F_v/F_n > 1 OK