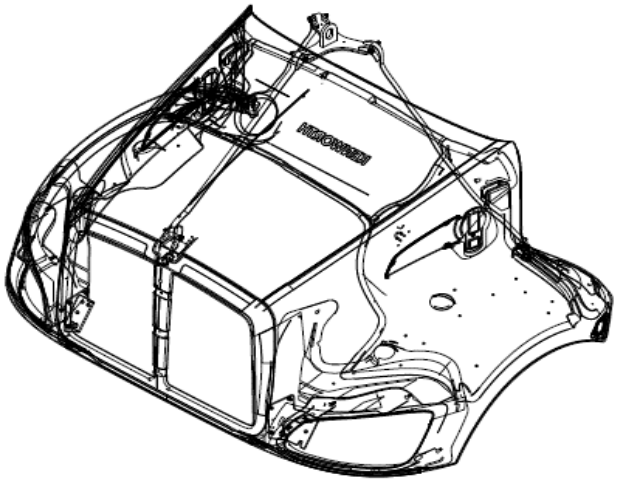
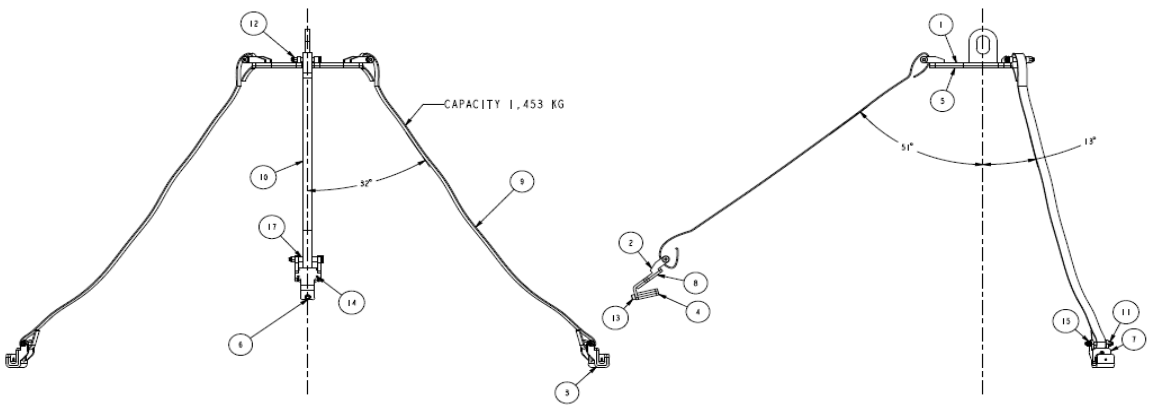
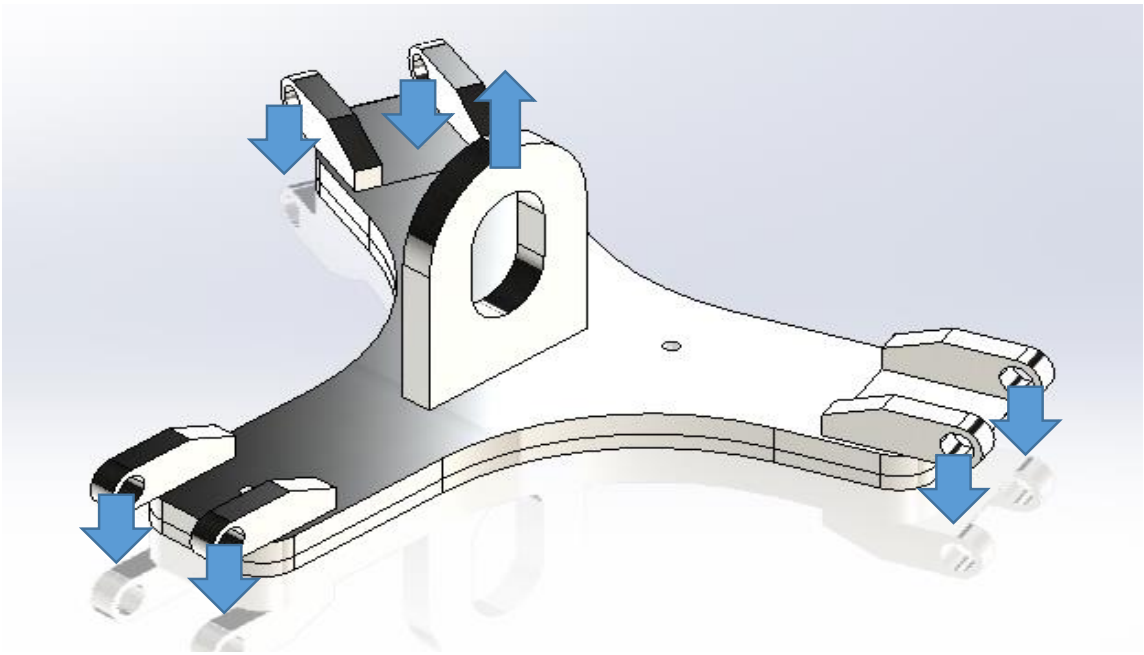
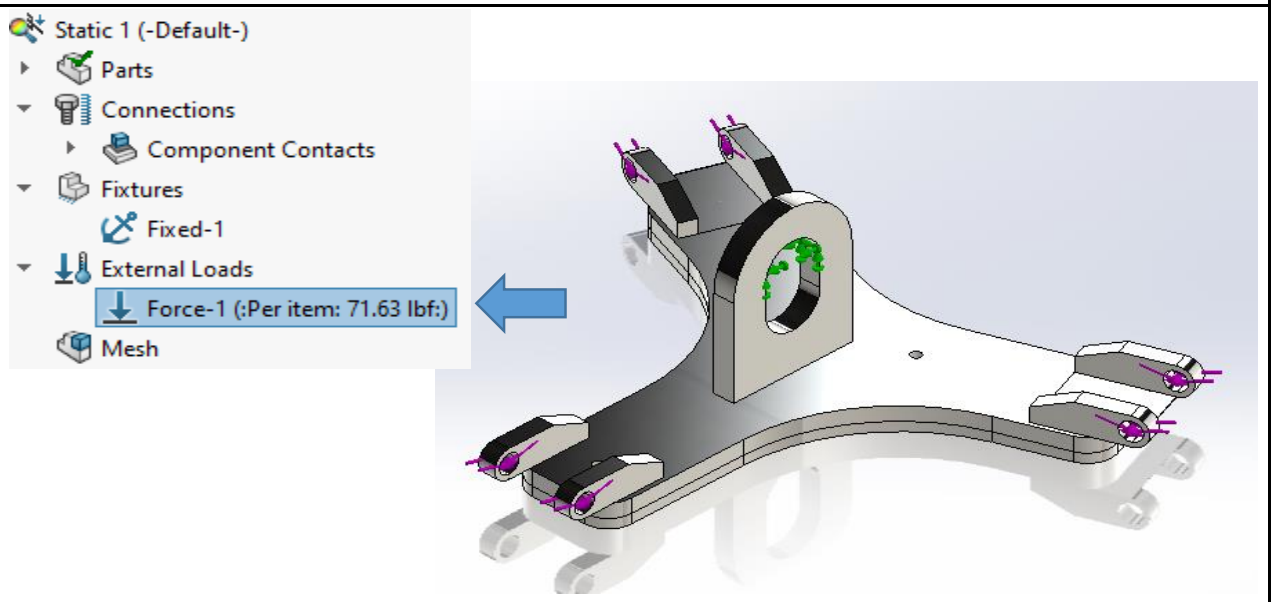
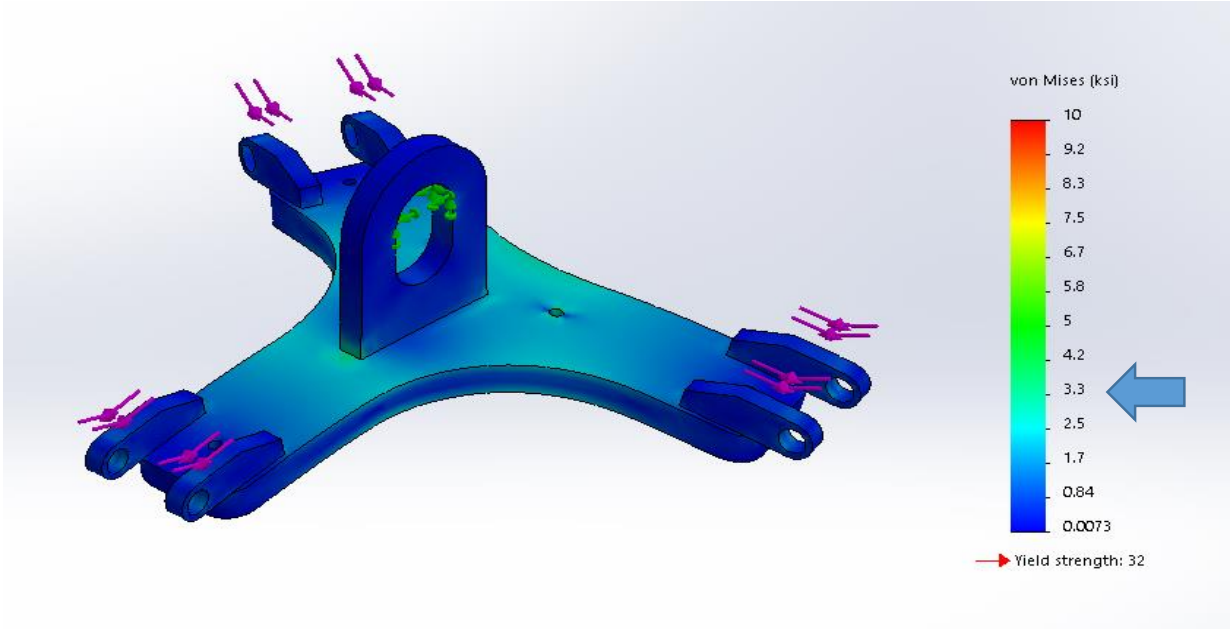
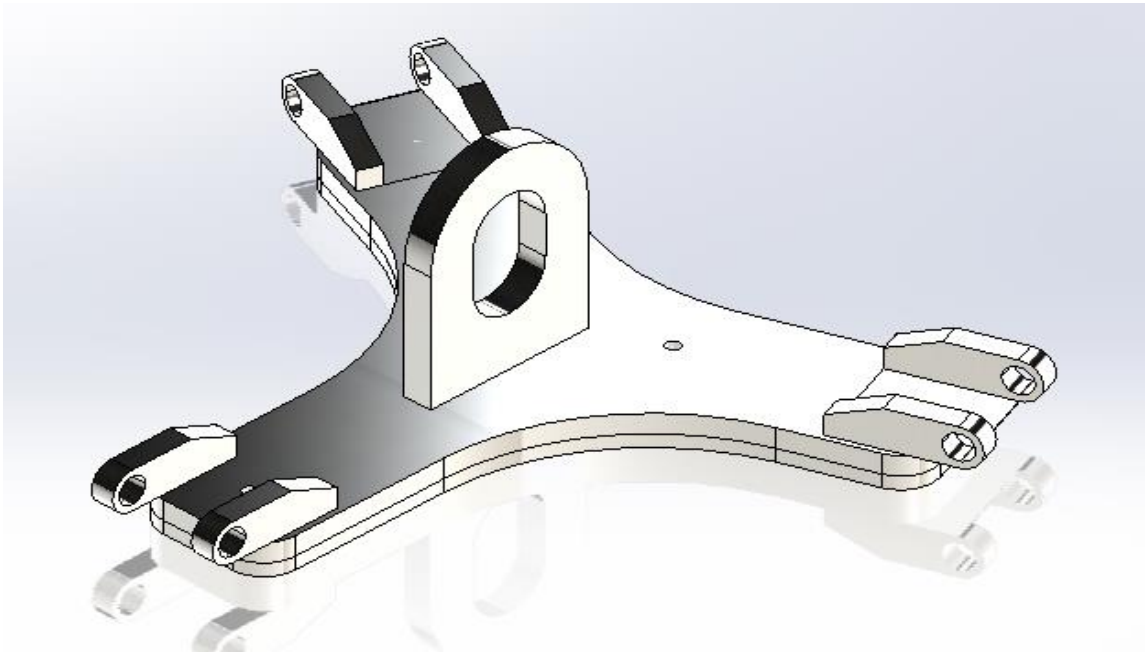
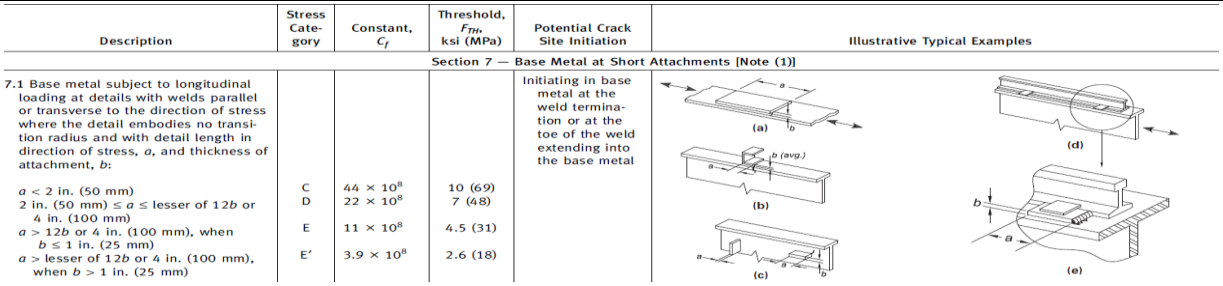
1	**Structural Calculations for DL-153 (Lifting Device for Hoods)**
2	**Summary of Analysis: Lifting Device is rated for 65 kg (143.3 lbs), Service Class 3**
3	**CERTIFICACION** DISPOSITIVO DE LEVANTE COFRES T270-/T370 ALTA: No. HERRAMIENTA: **DL-153** PESO: 6 KG CAPACIDAD: 65 KG PRUEBA: 82 KG LOCACION: LEC CATEGORIA **B** SERVICIO **3**
4	
5	Basis of Analysis: The overall lifting device is analyzed using Solidworks simulation.

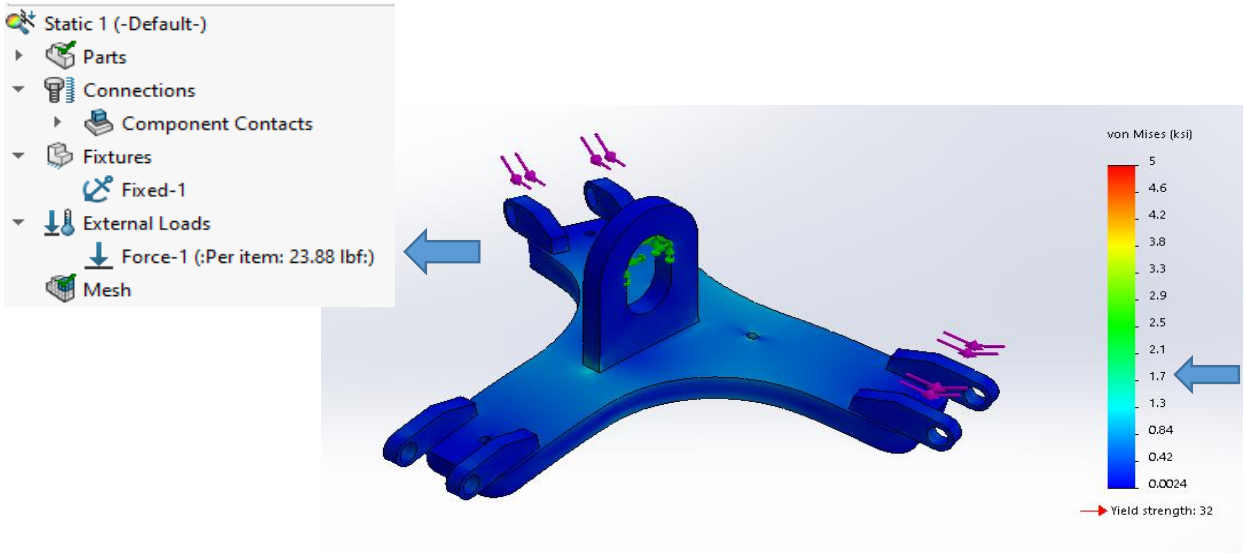
6	**Drawing of Lifting Device**		
7			
8	Code Reference: ASME BTH-1-2017, Below the Hook Lifting Devices; issued March 15, 2017		
9	Service Class	3	Per Drawing
10	**Table 2-3-1 Service Class** Service Class / Load Cycles 0 — 0–20,000 1 — 20,001–100,000 2 — 100,001–500,000 3 — 500,001–2,000,000 ← 4 — 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)	65.0	Weight lifted by device (defined by client on drawings)

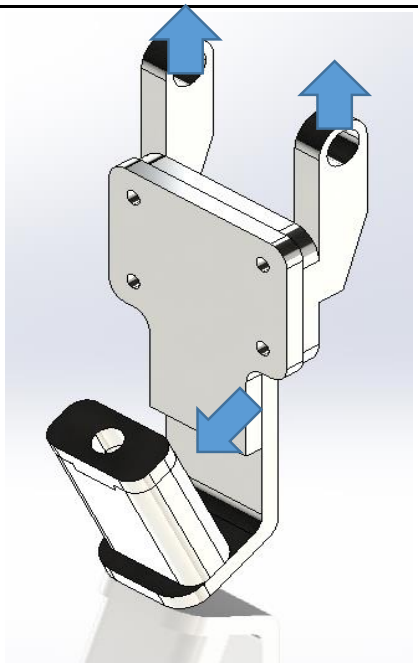
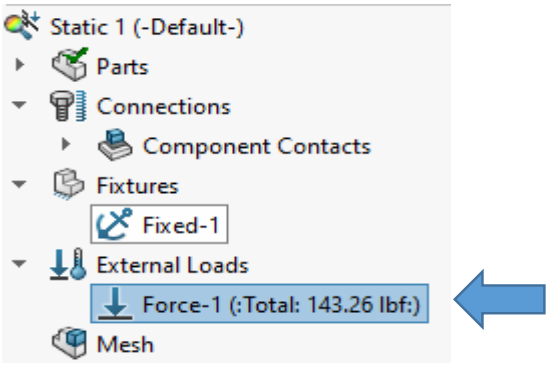
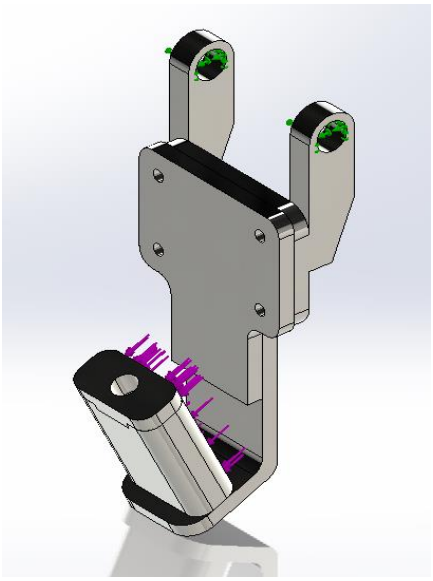
18	Job Load, J_{load} (lbs)	143.3	J_{load} x 2.2 lbs/kg
19	Using Solidworks, a model is created of the handling device (Detail 1 & 5)		
20			
21	Rated Force on Upper Connection Point, F (lbs)	143.3	Job Load
22	Design factor, Df	3	For Structure
23	Applied Force, AF (lbs)	429.78	F x Df
24	Applied Force per Load Point Aft, (lbs)	71.63	AF/6

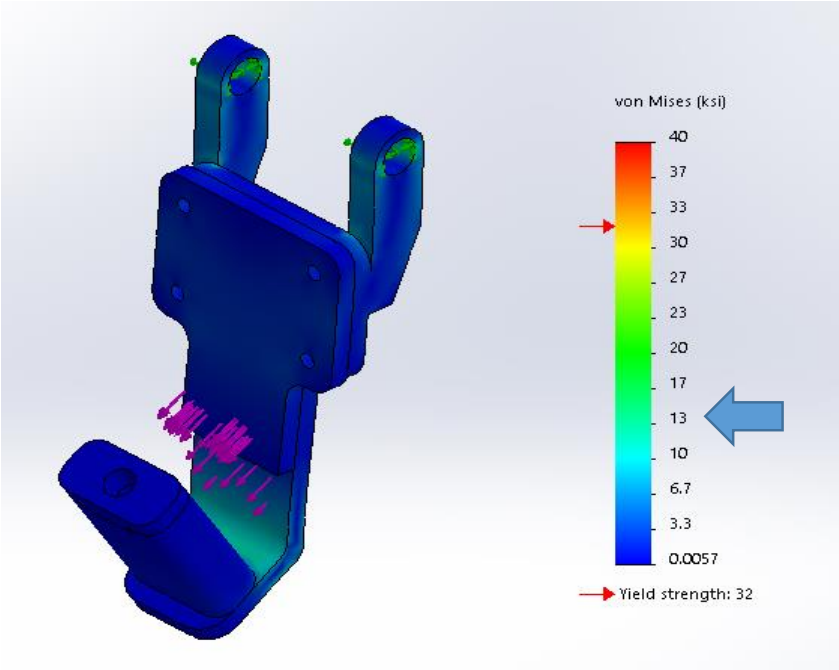
25	Apply the load to the Model using Solidworks Simulation		
26			
27	Run the Model		
28			
29	Max Von Mises Stress, Fm (ksi)	3.30	See above
30	Yield Strength of Material, Fy (ksi)	36.30	Mild Steel; assume A36 as worst case mild steel
31	Safety Factor	11.00	Fy/Fm = 1 OK

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			
36	Max Rated Load, W_{max} (lbs)	143.3	***Assumed loading 100% of time***
37	Max Rated Lift Point Load, W_{mc} (lbs)	23.88	$W_{max}/6$
38	Service Class	3	Per drawing

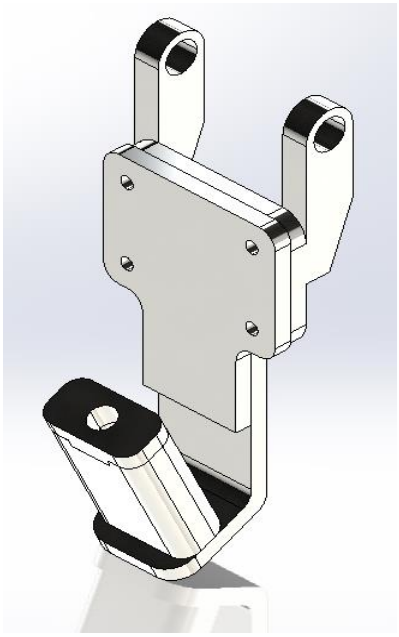
Description	Stress Category	Constant, C_f	Threshold, F_{TH}, ksi (MPa)	Potential Crack Site Initiation	Illustrative Typical Examples
Section 7 — Base Metal at Short Attachments [Note (1)]					
7.1 Base metal subject to longitudinal loading at details with welds parallel or transverse to the direction of stress where the detail embodies no transition radius and with detail length in direction of stress, a, and thickness of attachment, b:				Initiating in base metal at the weld termination or at the toe of the weld extending into the base metal	
$a < 2$ in. (50 mm)	C	44×10^8	10 (69)		
2 in. (50 mm) $\le a \le$ lesser of $12b$ or 4 in. (100 mm)	D	22×10^8	7 (48)		
$a > 12b$ or 4 in. (100 mm), when $b \le 1$ in. (25 mm)	E	11×10^8	4.5 (31)		
$a >$ lesser of $12b$ or 4 in. (100 mm), when $b > 1$ in. (25 mm)	E′	3.9×10^8	2.6 (18)		

39	**Table 2-3-1 Service Class** Service Class: 0 — Load Cycles: 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)	8.0	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 / 2 / 3 / 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)	1.7	See above
44	Safety Factor	4.71	$F_s/F_a > 1$ OK

45	Using Solidworks, a model is created of the handling device (Detail 2-4-6-8)		
46			
47	Rated Force on Upper Connection Point, F (lbs)	143.3	Job Load
48	Design factor, Df	3	For Structure
49	Applied Force, AF (lbs)	429.78	F x Df
50	Applied Force per Load Point Aft, (lbs)	143.26	AF/3
51	Detail 2-4-6-8		
52	 		

53	Run the Model		
54			
55	Max Von Mises Stress, Fm (ksi)	13.00	See above
56	Yield Strength of Material, Fy (ksi)	36.30	Mild Steel; assume A36 as worst case mild steel
57	Safety Factor	2.79	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

(Note: figures are for snug-tightened bolts, rivets, or other mechanical fasteners)

2.4 Base metal at net section of eyebar head or pin plate.	E	11×10^3	4.5 (31)	In net section originating at side of hole	(a) (b)

62	Max Rated Load, W_{max} (lbs)	143.3	***Assumed loading 100% of time***
63	Max Rated Lift Point Load, W_{mc} (lbs)	47.75	$W_{max}/3$
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)	8.0	Table 3-4.3-1, based on Service Class and worst case Stress Category for fatigue

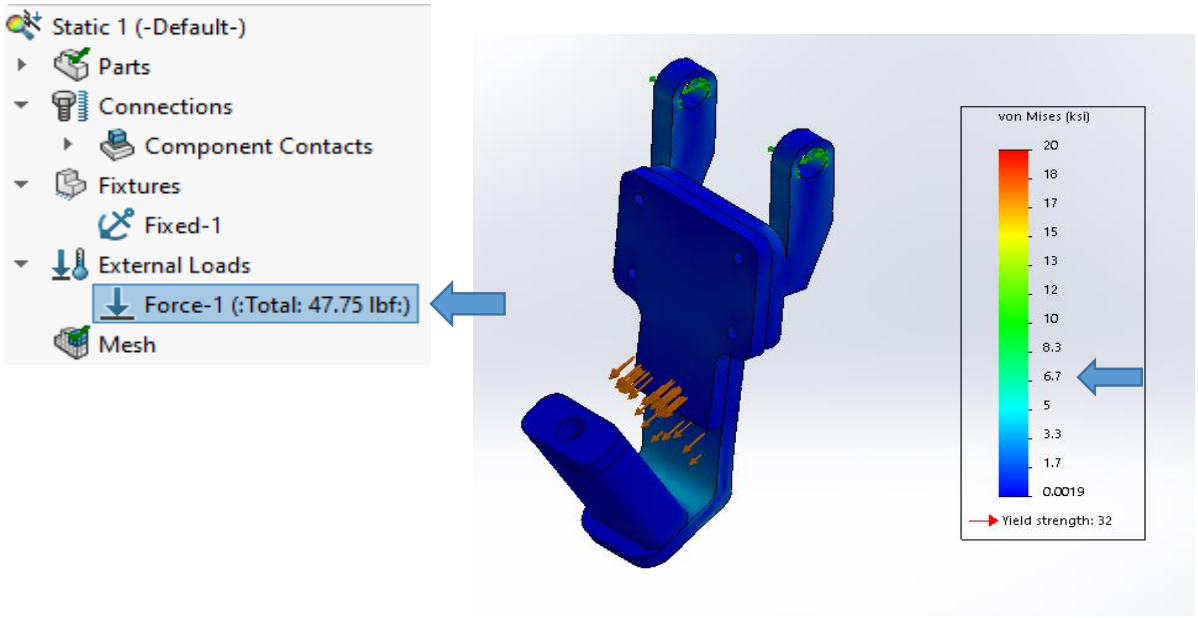
67

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

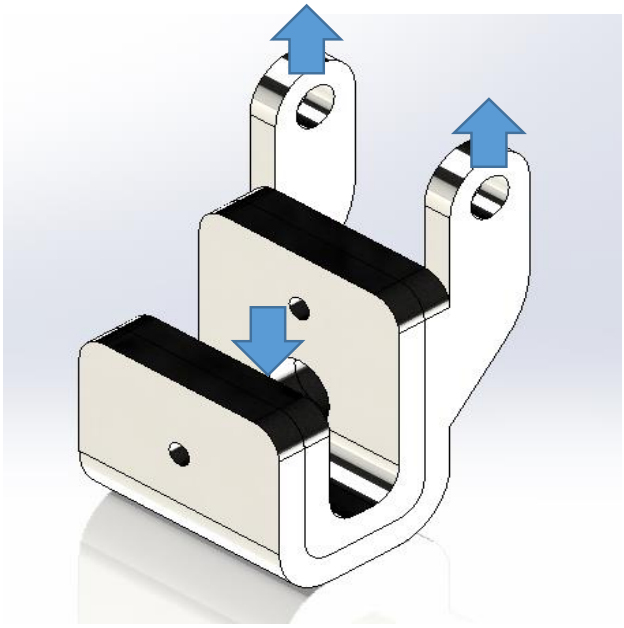
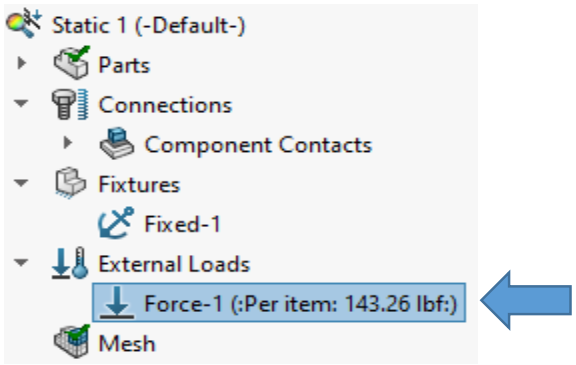
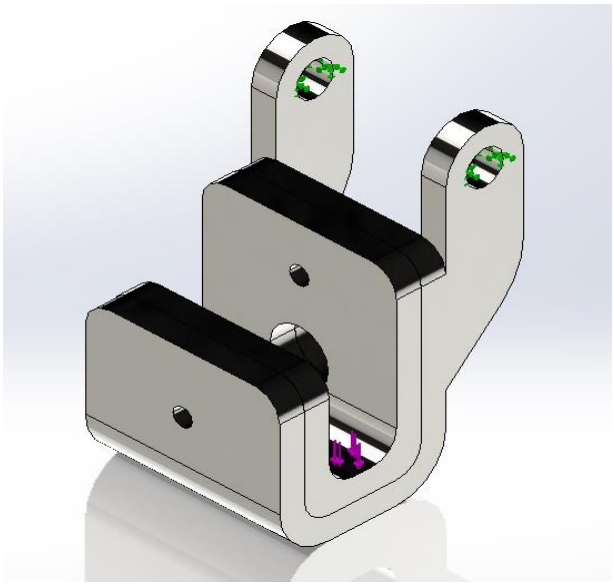
Stress Category (From Table 3-4.4-1)	Service Class 1	2	3	4
A	63 (435)	37 (255)	24 (165)	24 (165)
B	49 (340)	29 (200)	18 (125)	16 (110)
B'	39 (270)	23 (160)	15 (100)	12 (80)
C	35 (240)	21 (145)	13 (90)	10 (70) [Note (1)]
D	28 (190)	16 (110)	10 (70)	7 (48)
E	22 (150)	13 (90)	8 (55)	5 (34)
E'	16 (110)	9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

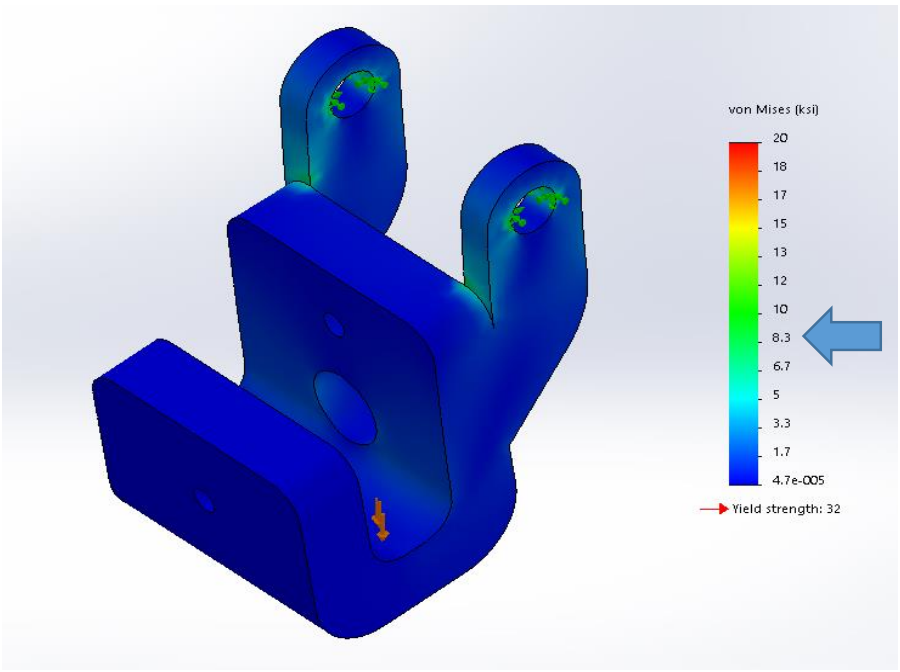
NOTE:
(1) Flexural stress range of 12 ksi (80 MPa) permitted at the toe of stiffener welds on flanges.

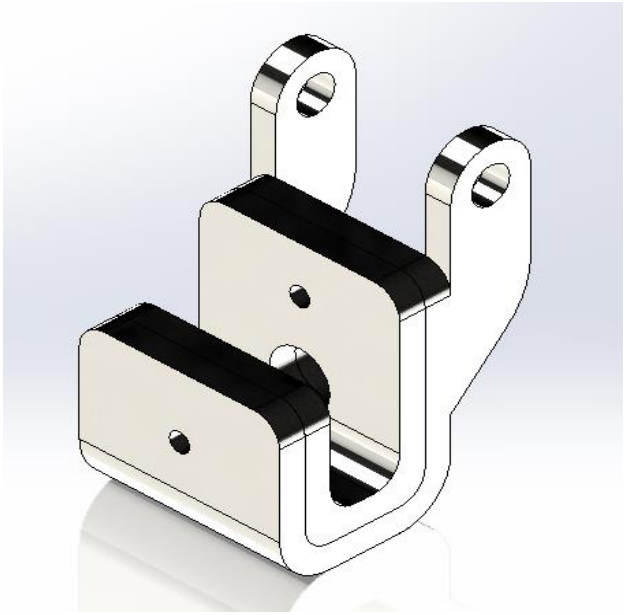
68



69	Actual Stress, F_a (ksi)	6.7	See above
70	Safety Factor	1.19	$F_s/F_a > 1$ OK

71	Detail 3 & 7		
72			
73	Rated Force on Upper Connection Point, F (lbs)	143.3	Job Load
74	Design factor, Df	3	For Structure
75	Applied Force, AF (lbs)	429.78	F x Df
76	Applied Force per Load Point Aft, (lbs)	143.26	AF/3
77	Apply the load to the Model using Solidworks Simulation		
78	 		

79	Run the Model		
80			
81	Max Von Mises Stress, Fm (ksi)	8.30	See above
82	Yield Strength of Material, Fy (ksi)	36.30	Mild Steel; assume A36 as worst case mild steel
83	Safety Factor	4.37	Fy/Fm = 1 OK
84	**Fatigue Analysis**		
85	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):		

86			
87	(Note: figures are for snug-tightened bolts, rivets, or other mechanical fasteners) 2.4 Base metal at net section of eyebar head or pin plate. | E | 11 × 10[8] | 4.5 (31) | In net section originating at side of hole (a) (b)		
88	Max Rated Load, W_{max} (lbs)	143.3	***Assumed loading 100% of time***
89	Max Rated Lift Point Load, W_{mc} (lbs)	47.75	$W_{max}/3$
90	Service Class	3	Per drawing
91	**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		

92	Allowable Stress Range, Fs (ksi)	8.0	Table 3-4.3-1, based on Service Class and worst case Stress Category for fatigue

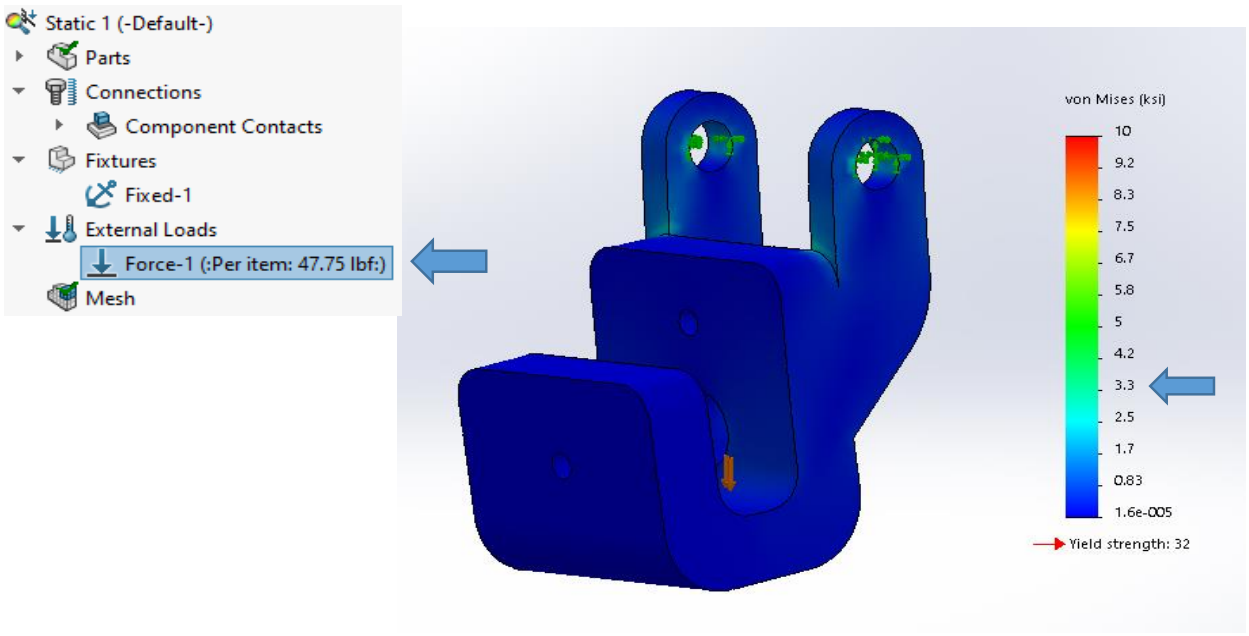
93

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

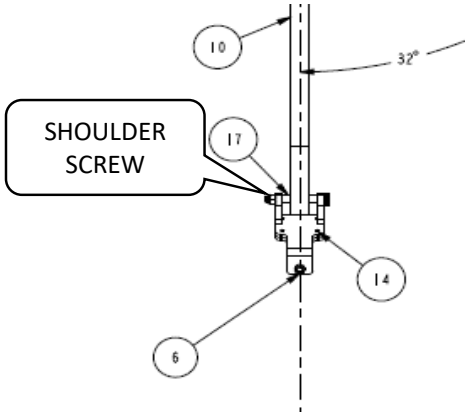
Stress Category (From Table 3-4.4-1)	Service Class 1	2	3	4
A	63 (435)	37 (255)	24 (165)	24 (165)
B	49 (340)	29 (200)	18 (125)	16 (110)
B'	39 (270)	23 (160)	15 (100)	12 (80)
C	35 (240)	21 (145)	13 (90)	10 (70) [Note (1)]
D	28 (190)	16 (110)	10 (70)	7 (48)
E	22 (150)	13 (90)	8 (55)	5 (34)
E'	16 (110)	9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

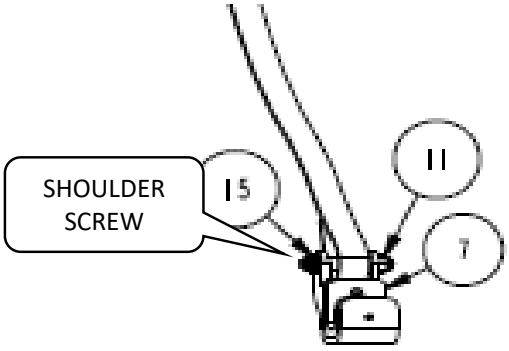
NOTE:
(1) Flexural stress range of 12 ksi (80 MPa) permitted at the toe of stiffener welds on flanges.

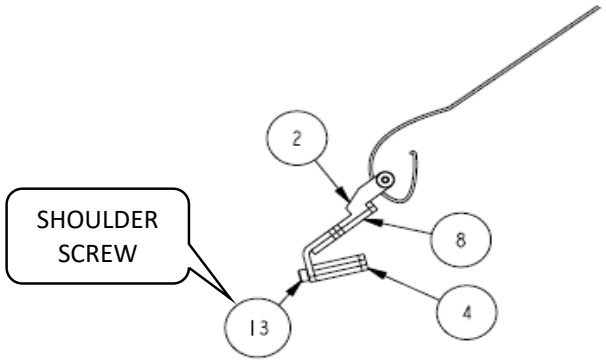
94

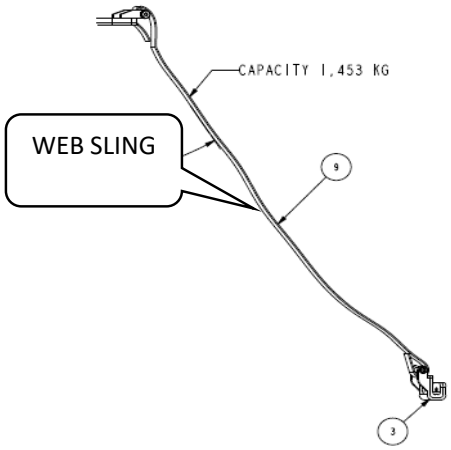


95	Actual Stress, F_a (ksi)	3.3	See above
96	Safety Factor	2.42	$F_s/F_a > 1$ OK

45	**Other Rated Components**		
46			
47	**Alloy Steel Shoulder Screw** 1/2" Shoulder Diameter, 2-3/4" Shoulder Length, 3/8"-16 Thread  Each ADD TO ORDER In stock 1-4 Each $3.42 5 or more $2.91 91259A723 Shoulder Fit: Standard Shoulder Diameter: 1/2" Shoulder Diameter Tolerance: -0.004" to -0.002" Shoulder Length: 2 3/4" Shoulder Length Tolerance: -0.005" to 0.005" Thread Size: 3/8"-16 Screw Size Decimal Equivalent: 0.375" Thread Type: UNC Thread Spacing: Coarse Thread Fit: Class 3A Thread Direction: Right Hand Thread Length: 5/8" Head Diameter: 3/4" Head Height: 5/16" Material: Alloy Steel Finish: Black Oxide Hardness: Rockwell C32 Tensile Strength: 140,000 psi		
48	Max Rated Load, W_{max} (lbs)	429.8	***Assumed loading 100% of time***
49	Max Rated Lift Point Load, W_{mc} (lbs)	143.26	$W_{max/3}$
50	Surface Area, A (in^2)	0.110	$A = \pi r^2 \times 2$, double shear
51	Shear stress, τ (psi)	1,297.10	$\tau = F/A$
52	Tensile Strength of Material, Ft (psi)	140,000.0	from mfr. Info
53	Shear Strength of Material, v (psi)	80,780.00	$0.577 \times f_y$
54	Safety Factor	62.28	$=V/\tau > 1$ OK

55			
56	**Alloy Steel Shoulder Screw** 3/8" Shoulder Diameter, 2" Shoulder Length, 5/16"-18 Thread  Each ADD TO ORDER In stock 1-4 Each $2.03 5 or more $1.72 91259A632 Shoulder Fit: Standard Shoulder Diameter: 3/8" Shoulder Diameter Tolerance: -0.004" to -0.002" Shoulder Length: 2" Shoulder Length Tolerance: -0.005" to 0.005" Thread Size: 5/16"-18 Screw Size Decimal Equivalent: 0.313" Thread Type: UNC Thread Spacing: Coarse Thread Fit: Class 3A Thread Direction: Right Hand Thread Length: 1/2" Head Diameter: 9/16" Head Height: 1/4" Material: Alloy Steel Finish: Black Oxide Hardness: Rockwell C32 Tensile Strength: 140,000 psi		
57	Max Rated Load, W_{max} (lbs)	429.8	***Assumed loading 100% of time***
58	Max Rated Lift Point Load, W_{mc} (lbs)	143.26	$W_{max/3}$
59	Surface Area, A (in²)	0.077	$A = \pi r^2 \times 2$, double shear
60	Shear stress, τ (psi)	1,861.86	$\tau = F/A$
61	Tensile Strength of Material, Ft (psi)	140,000.0	from mfr. Info
62	Shear Strength of Material, v (psi)	80,780.00	$0.577 \times f_y$
63	Safety Factor	43.39	$=V/\tau > 1$ OK

64			
65	**Black-Oxide Alloy Steel Socket Head Screw** 3/8"-16 Thread Size, 2-1/2" Long, Partially Threaded  Packs of 10 In stock $6.44 per pack of 10 ADD TO ORDER 91251A634 Head Type: Socket Socket Head Profile: Standard Drive Style: Hex System of Measurement: Inch Thread Direction: Right Hand Thread Size: 3/8"-16 Screw Size Decimal Equivalent: 0.375" Thread Type: UNC Thread Fit: Class 3A Length: 2 1/2" Threading: Partially Threaded Min. Thread Length: 1 1/4" Thread Spacing: Coarse Head Diameter: 9/16" Height: 3/8" Drive Size: 5/16" Material: Black-Oxide Alloy Steel Tensile Strength: 170,000 psi		
66	Max Rated Load, W_{max} (lbs)	429.8	***Assumed loading 100% of time***
67	Max Rated Lift Point Load, W_{mc} (lbs)	143.26	$W_{max/3}$
68	Surface Area, A (in^2)	0.110	$A = \pi r^2$
69	Shear stress, τ (psi)	1,297.10	$\tau = F/A$
70	Tensile Strength of Material, Ft (psi)	170,000.0	from mfr. Info
71	Shear Strength of Material, v (psi)	98,090.00	0.577 x f_y
72	Safety Factor	75.62	=V/τ >1 OK

73			
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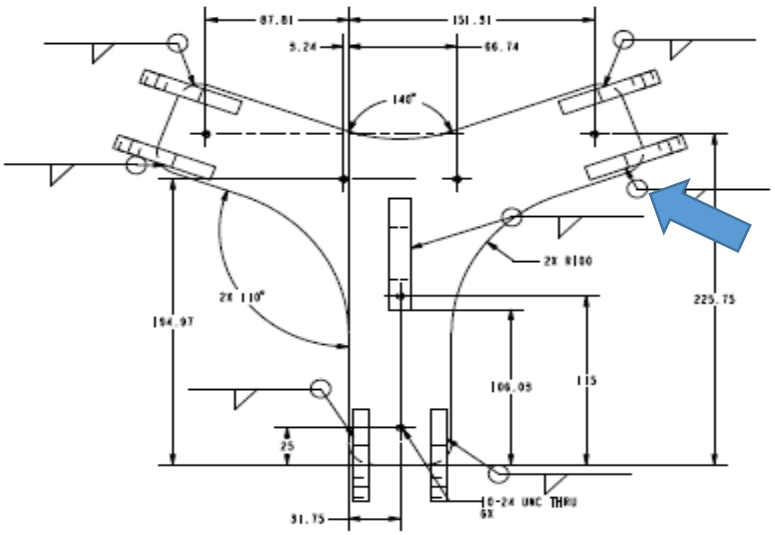
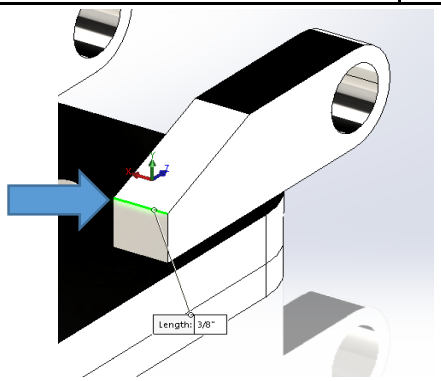
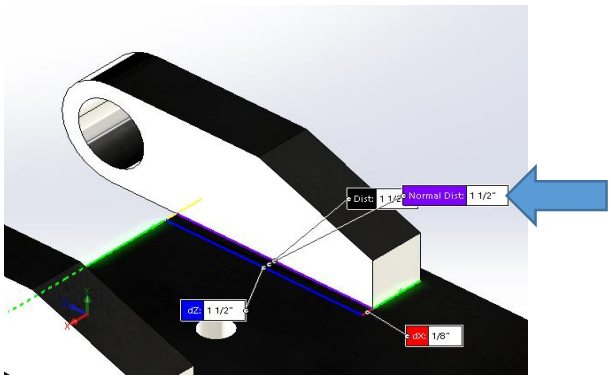
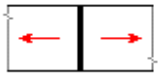
	Tuff-Edge II Part No.	Web Width (in.)	Rated Capacity * (lbs.) Vertical	Choker	V. Basket	Webmaster Part No. ***
One Ply	EE1801TF	1	1,600	1,280	3,200	EE1801DF
	EE1802TF	2	3,200	2,500	6,400	EE1802DF
	EE1803TF	3	4,800	3,800	9,600	EE1803DF
	EE1804TF	4	6,400	5,000	12,800	EE1804DF
	EE1806TF	6	9,600	7,700	19,200	EE1806DF
	EE1808TF	8	12,800	10,200	25,600	EE1808DF
	EE1810TF	10	16,000	12,800	32,000	EE1810DF
	EE1812TF	12	19,200	15,400	38,400	EE1812DF
Two	EE2801TF	1	3,200	00	6,400	EE2801DF
	EE2802TF	2	6,400	5,000	12,800	EE2802DF
	EE2803TF	3	8,800	7,040	17,600	EE2803DF
	EE2804TF	4	11,500	9,200	23,000	EE2804DF

75	Part Rating, R (lbs)	3,200	See above
76	Factored Job Load, FJ_{load} (lbs)	143.3	J_{load} x Nominal Design Factor
77	Safety Factor	22.34	R / FJ_{load} >>1 OK

78	**Connection Weld Analysis -Detail 1**		
79			
80	*(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)		
81	Allowable Stress, F_v (ksi)	11.667	See above Eqn. 3-55
82	Nominal Tensile Strength of weld material, E_{xx} (ksi)	70	Typical Value
83	**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)		
84	Tensile Load, T_n (kips)	0.43	Iterative until safety factor met
85	Length of Tab, L (in)	1.50	L
86	Thickness of Tab, t (in)	3/8	W

87	Length of Fillet Weld, L (in)	3.75	2L x 2W
88	 		
89	Weld Leg, W_{leg} (in)	0.13	Refer to Table 3-3.4.3-1
90	Nominal Stress on Weld, F_n (ksi)	1.30	See below eqn (area of weld = length x effective throat thickness)
91	**Load** / Tensile/Press.  / **Rated stress** [MPa, psi] $\sigma_{\perp} = \frac{F_n}{A_w} = \frac{F_n}{L \cdot a}$		a = .707 x Wl
92	Safety Factor	8.99	F_v/F_n > 1 OK