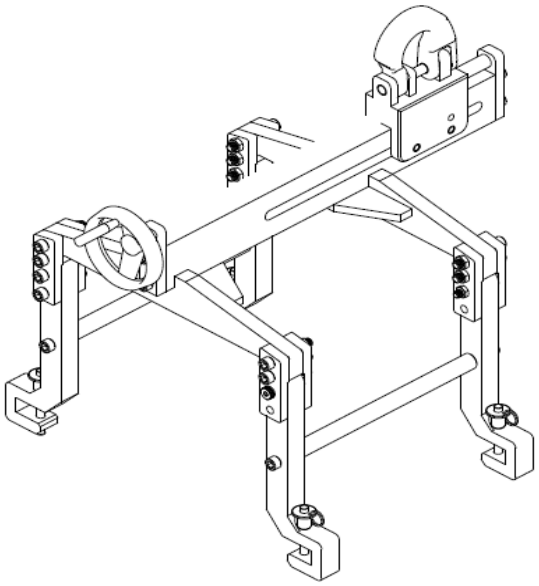
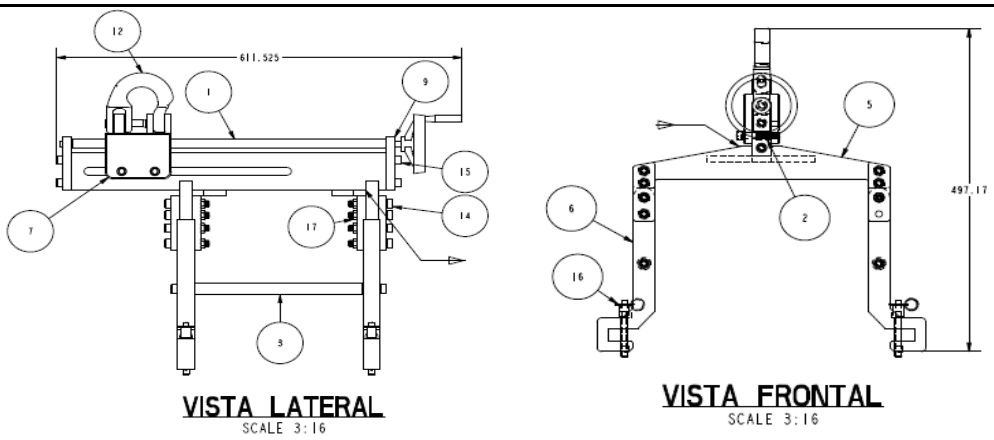
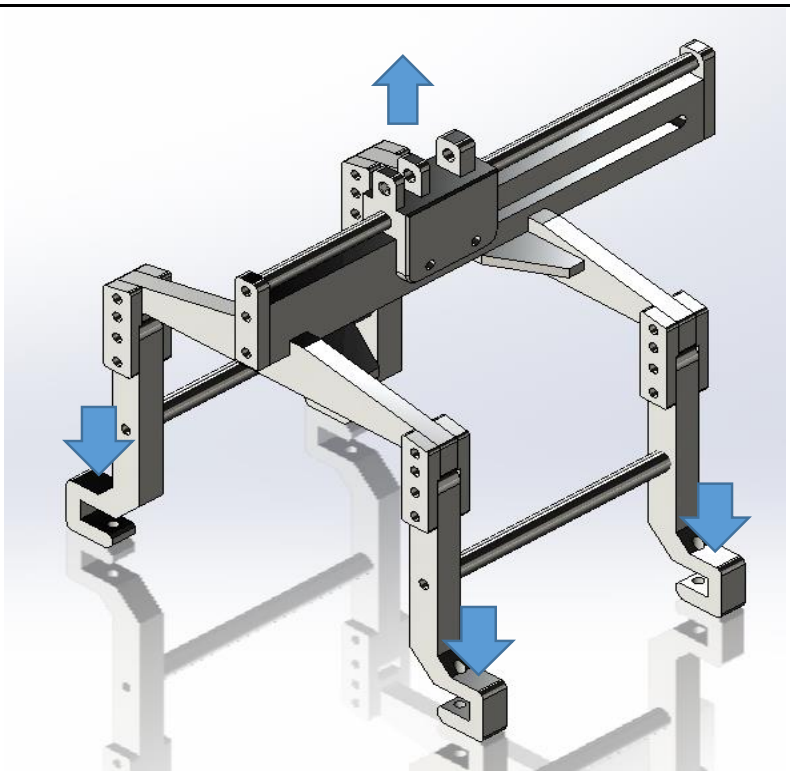
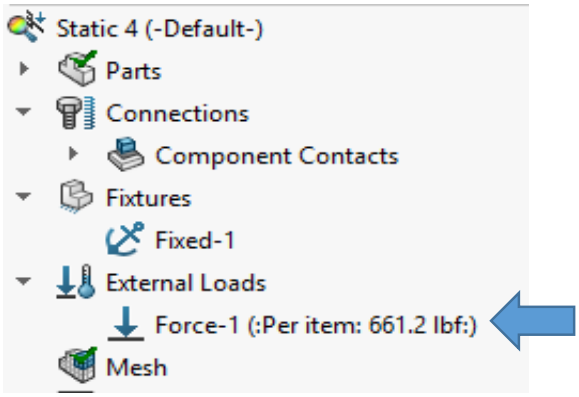
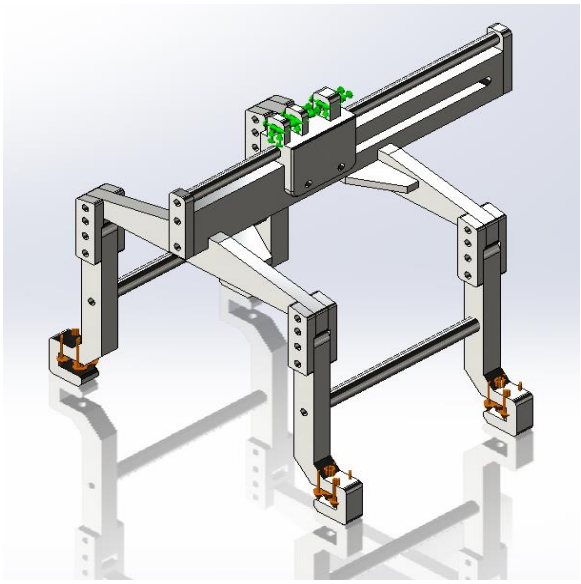
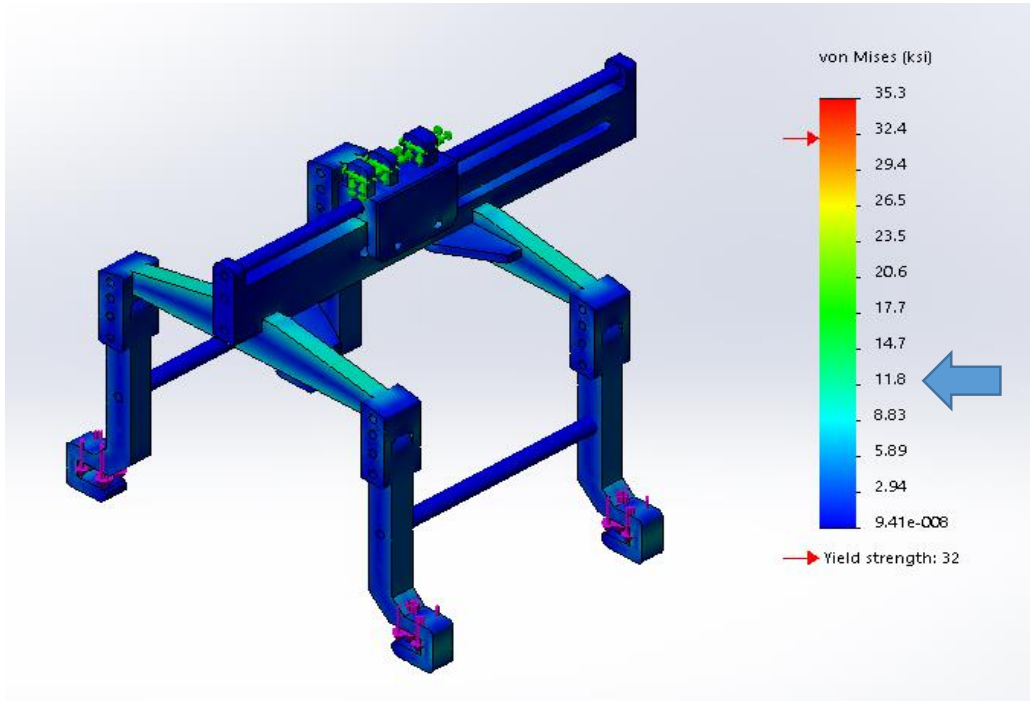
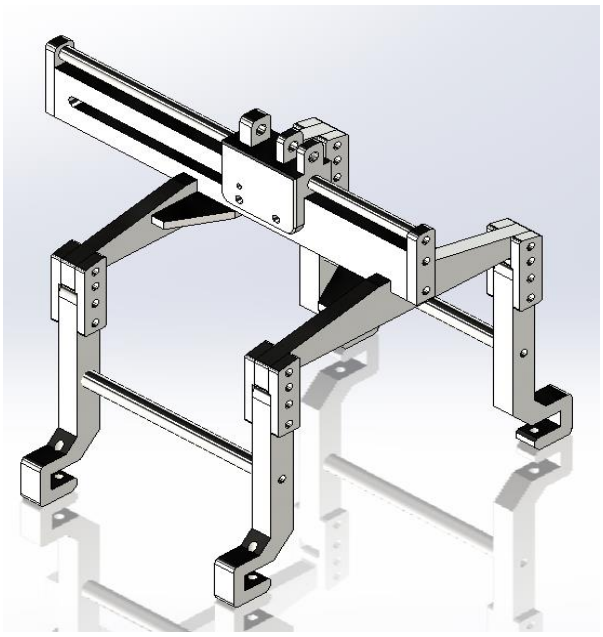
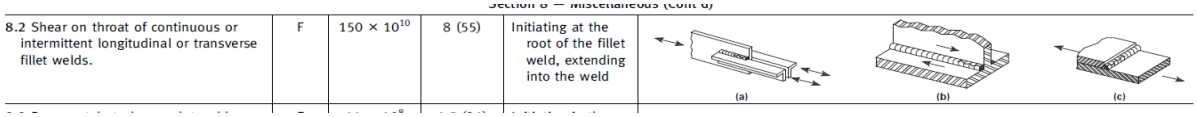
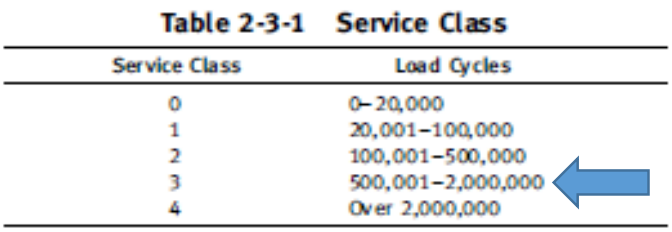
1	**Structural Calculations for DL-213 (LIFTING DEVICE FOR ALLISON TRANSMISSION)**
2	**Summary of Analysis: Lifting Device is rated for 400 kg (881.8 lbs), Service Class 3**
3	**CERTIFICACION** DISPOSITIVO DE LEVANTE PARA TRANSMISION ALLISON ALTA: No. HERRAMIENTA: **DL-213** PESO: 25 KG CAPACIDAD: 400 KG PRUEBA: 500 KG LOCACION: VESTIDURA DE MOTOR CATEGORIA **B** SERVICIO **3**
4	 VISTA ISOMETRICA ESCALA 1:4
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 0: Load Cycles 0–20,000 Service Class 1: Load Cycles 20,001–100,000 Service Class 2: Load Cycles 100,001–500,000 Service Class 3: Load Cycles 500,001–2,000,000 ← Service Class 4: Load Cycles 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)	400.0	Weight lifted by device (defined by client on drawings)
18	Job Load, J_{load} (lbs)	881.6	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)	881.6	Job Load
22	Design factor, Df	3	For Structure
23	Applied Force, AF (lbs)	2,644.80	F x Df
24	Applied Force per Load Point Aft, (lbs)	661.20	AF/4

25	Apply the load to the Model using Solidworks Simulation		
26	 		
27	Run the Model		
28			
29	Max Von Mises Stress, Fm (ksi)	11.80	See above
30	Yield Strength of Material, Fy (ksi)	36.30	Mild Steel; assume A36 as worst case mild steel
31	Safety Factor	3.08	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)	881.6	***Assumed loading 100% of time***
37	Max Rated Lift Point Load, W_{mc} (lbs)	220.40	$W_{max}/4$
38	Service Class	3	Per drawing
39			

8.2 Shear on throat of continuous or intermittent longitudinal or transverse fillet welds. | F | 150×10^{10} | 8 (55) | Initiating at the root of the fillet weld, extending into the weld

(a) (b) (c)

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)	9.0	Table 3-4.3-1, based on Service Class and worst case Stress Category for fatigue

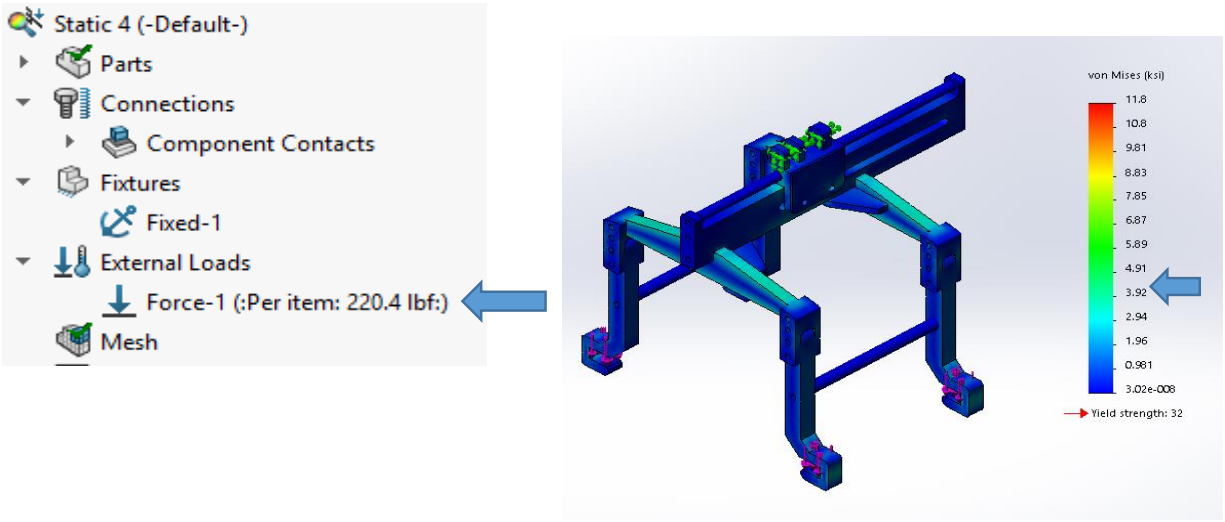
41

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

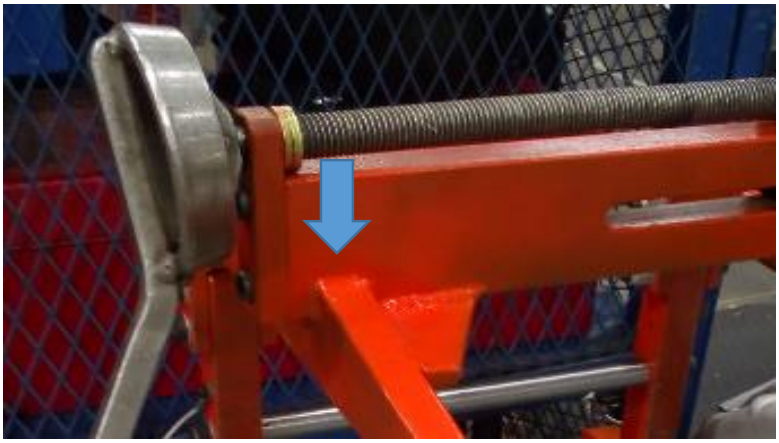
Stress Category (From Table 3-4.4-1)	Service Class 1	2	3	4
A	63 (435)	37 (255)	24 (165)	24 (165)
B	49 (340)	29 (200)	18 (125)	16 (110)
B'	39 (270)	23 (160)	15 (100)	12 (80)
C	35 (240)	21 (145)	13 (90)	10 (70) [Note (1)]
D	28 (190)	16 (110)	10 (70)	7 (48)
E	22 (150)	13 (90)	8 (55)	5 (34)
E'	16 (110)	9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

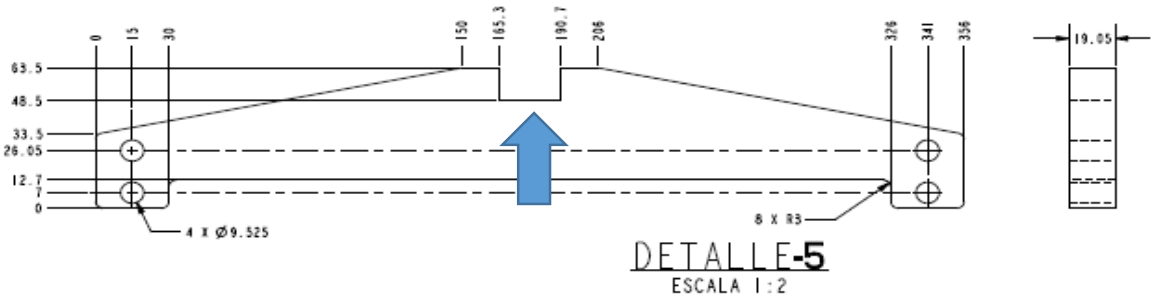
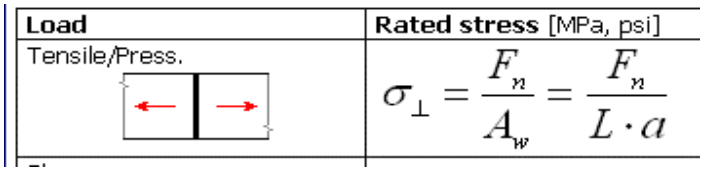
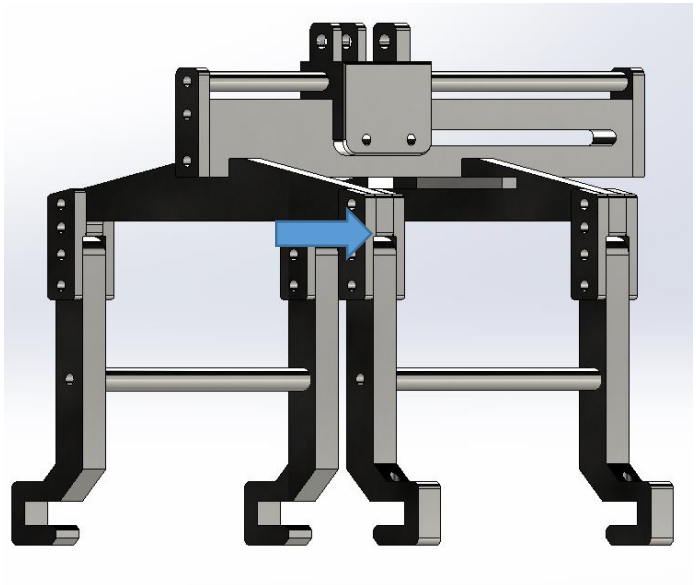
NOTE:
(1) Flexural stress range of 12 ksi (80 MPa) permitted at the toe of stiffener welds on flanges.

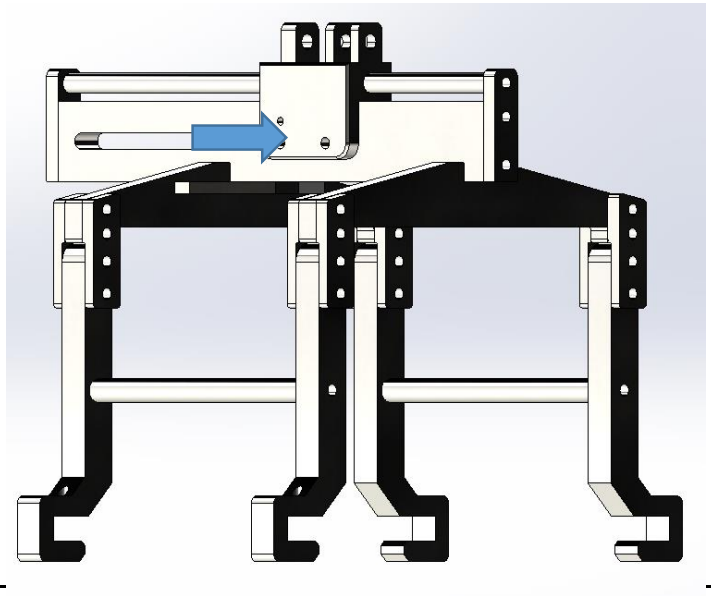
42

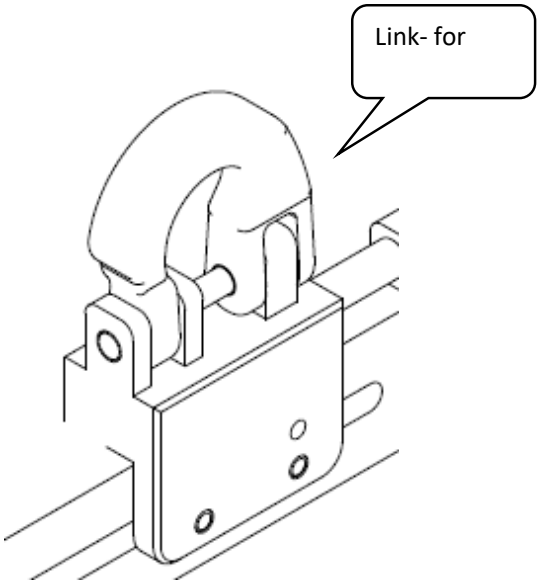
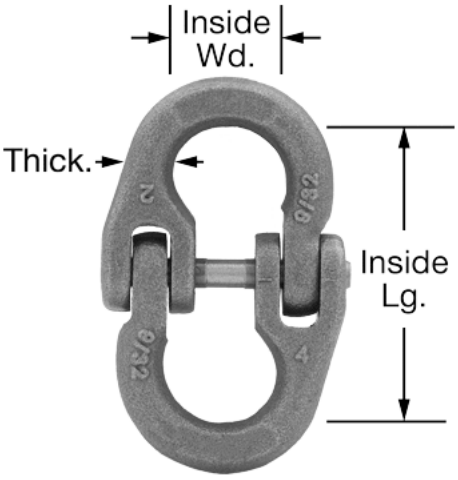


43	Actual Stress, F_a (ksi)	3.92	See above
44	Safety Factor	2.30	$F_s/F_a > 1$ OK

45	**Connection Weld Analysis -Top Lift Tab**		
46			
47	*(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)		
48	Allowable Stress, F_v (ksi)	11.667	See above Eqn. 3-55
49	Nominal Tensile Strength of weld material, E_{xx} (ksi)	70	Typical Value
50	**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)		
51	Tensile Load, T_n (kips)	7	Iterative until safety factor met
52	Length of Tab, L (in)	-	N/A - custom geometry
53	Thickness of Tab, t (in)	-	N/A - custom geometry
54	Length of Fillet Weld, L (in)	4.45	25+15+15+19.05+19.05 +10+10=113.1 mm (4.45 inch)

55			
56	Weld Leg, W_{leg} (in)	0.75	Approximated from observation, conservative
57	Nominal Stress on Weld, F_n (ksi)	2.96	See below eqn (area of weld = length x effective throat thickness)
58			a = .707 x Wl
59	Safety Factor	3.94	F_v/F_n > 1 OK
60	**Shear Analysis**		
61			
62	Max Rated Load, W_{max} (lbs)	881.6	***Assumed loading 100% of time***
63	Max Rated Lift Point Load, W_{mc} (lbs)	220.40	$W_{max}/4$
64	Surface Area, A (in^2)	0.1	$A = \pi r^2 \times 2$
65	Shear stress, τ (psi)	1,995.53	$\tau = F/A$

66	Tensile Strength of Material, f_y (psi)	58,000.0	f_y
67	Shear Strength of Material, v (psi)	33,466.00	0.577 x f_y
68	Shear Str. of Mat. > Shear Stress (psi)	33.5 > 2	v > τ
69			
70	Max Rated Load, W_{max} (lbs)	881.6	***Assumed loading 100% of time***
71	Max Rated Lift Point Load, W_{mc} (lbs)	440.80	$W_{max}/2$
72	Surface Area, A (in²)	0.1	$A = \pi r^2 \times 2$
73	Shear stress, τ (psi)	3,886.73	$\tau = F/A$
74	Tensile Strength of Material, f_y (psi)	58,000.0	f_y
75	Shear Strength of Material, v (psi)	33,466.00	0.577 x f_y
76	Shear Str. of Mat. > Shear Stress (kpsi)	33.5 > 4	v > τ
77	**The lifting device meets the allowable stress range for Service Class 3 cycle requirements.**		

78	**Other Rated Components**		
79			
80	**Figure-Eight Connecting Link - for Lifting** Removable, Grade 100, Black Alloy Steel, for 5/8 Chain Size  Each In stock $71.79 Each 33585T66 ADD TO ORDER Grade: 100 Material: Black Ultra-Corrosion-Resistant Coated Alloy Steel For Chain Trade Size: 5/8 Thickness: 15/16" Inside Length: 4 13/32" Inside Width: 1 11/32" Capacity: 22,600 lbs. Fabrication: Forged Specifications Met: ASME B30.26 Fitting Type: Link/Ring Application: For Lifting RoHS: Not Compliant		
81	Part Rating, R (lbs)	22,600	See above
82	Factored Job Load, FJ_{load} (lbs)	2,644.8	J_{load} x Nominal Design Factor
83	Safety Factor	8.55	R / FJ_{load} >>1 OK