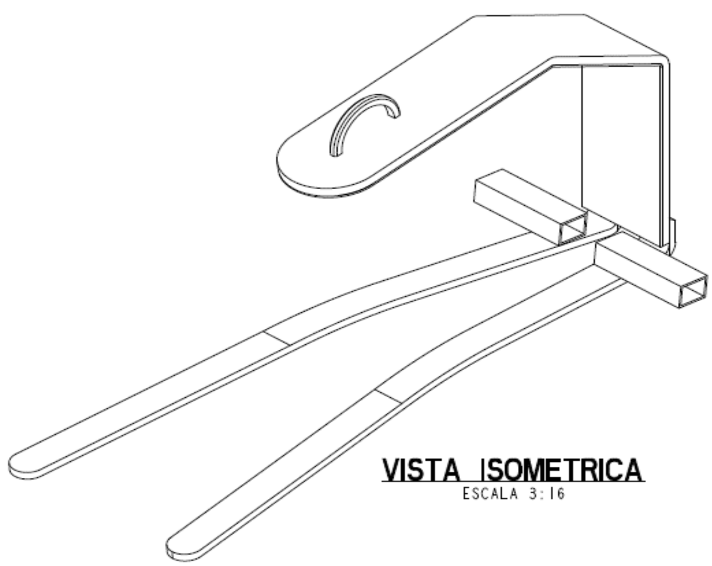
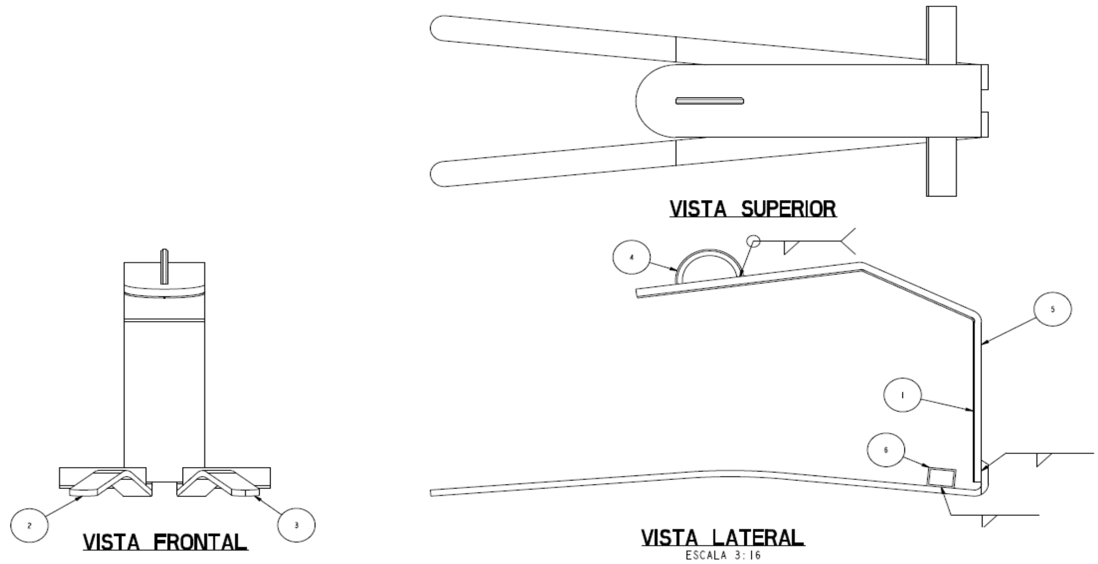
<table>
<tr><td>1</td><td>Structural Calculations for DL-031</td></tr>
<tr><td>2</td><td>Summary of Analysis: Lifting Device is rated for 50 kg (110.2 lbs), Service Class 3</td></tr>
<tr><td>3</td><td>
<table>
<tr><td colspan="3">CERTIFICACION</td></tr>
<tr><td colspan="3">TITLE_1:1 TITLE_2:1 TITLE_3:1</td></tr>
<tr><td>ALTA:</td><td></td><td rowspan="8"></td></tr>
<tr><td>No. HERRAMIENTA:</td><td>DL-031</td></tr>
<tr><td>PESO:</td><td>30 KGS</td></tr>
<tr><td>CAPACIDAD:</td><td>50 KGS</td></tr>
<tr><td>PRUEBA:</td><td>63 KGS</td></tr>
<tr><td>LOCACION:</td><td>KENMEX</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>

<table>
<tr><td>6</td><td colspan="3">Drawing of Lifting Device</td></tr>
<tr><td>7</td><td colspan="3">
</td></tr>
<tr><td>8</td><td colspan="3">Code Reference: ASME BTH-1-2017, Below the Hook Lifting Devices; issued March 15, 2017</td></tr>
<tr><td>9</td><td>Service Class</td><td>3</td><td>Per Drawing</td></tr>
<tr><td>10</td><td colspan="3">Table 2-3-1 Service Class
<table>
<tr><th>Service Class</th><th>Load Cycles</th></tr>
<tr><td>0</td><td>0–20,000</td></tr>
<tr><td>1</td><td>20,001–100,000</td></tr>
<tr><td>2</td><td>100,001–500,000</td></tr>
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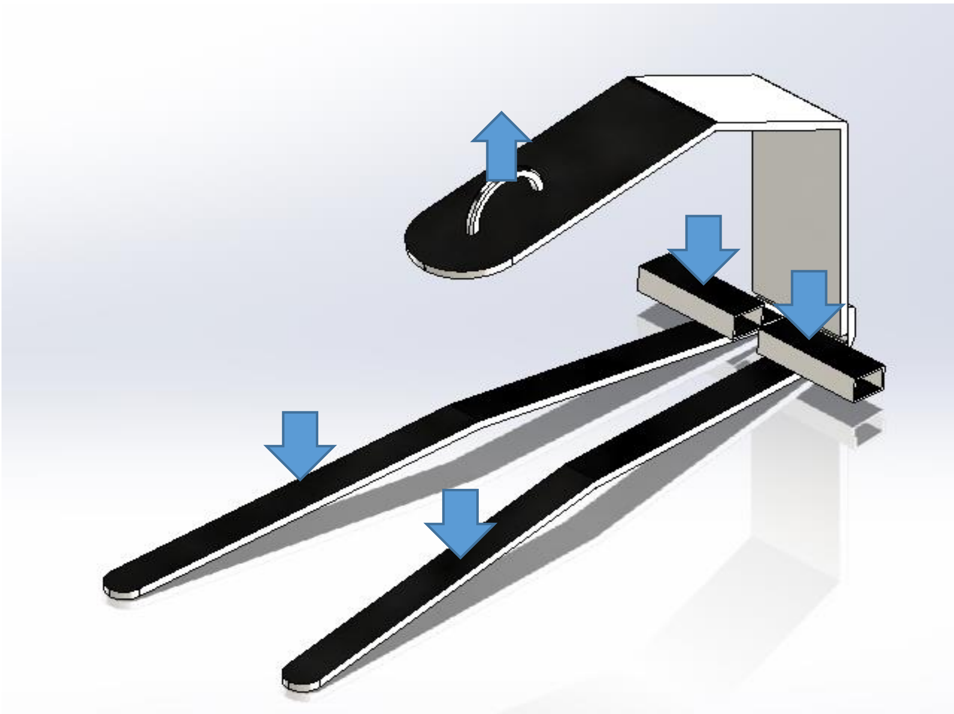
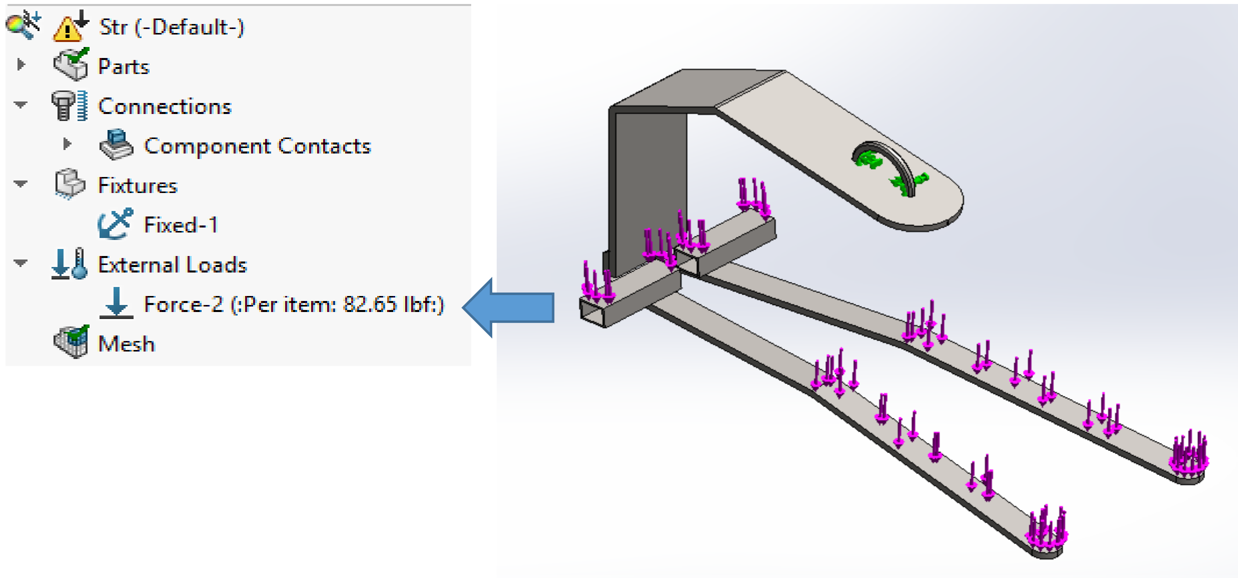
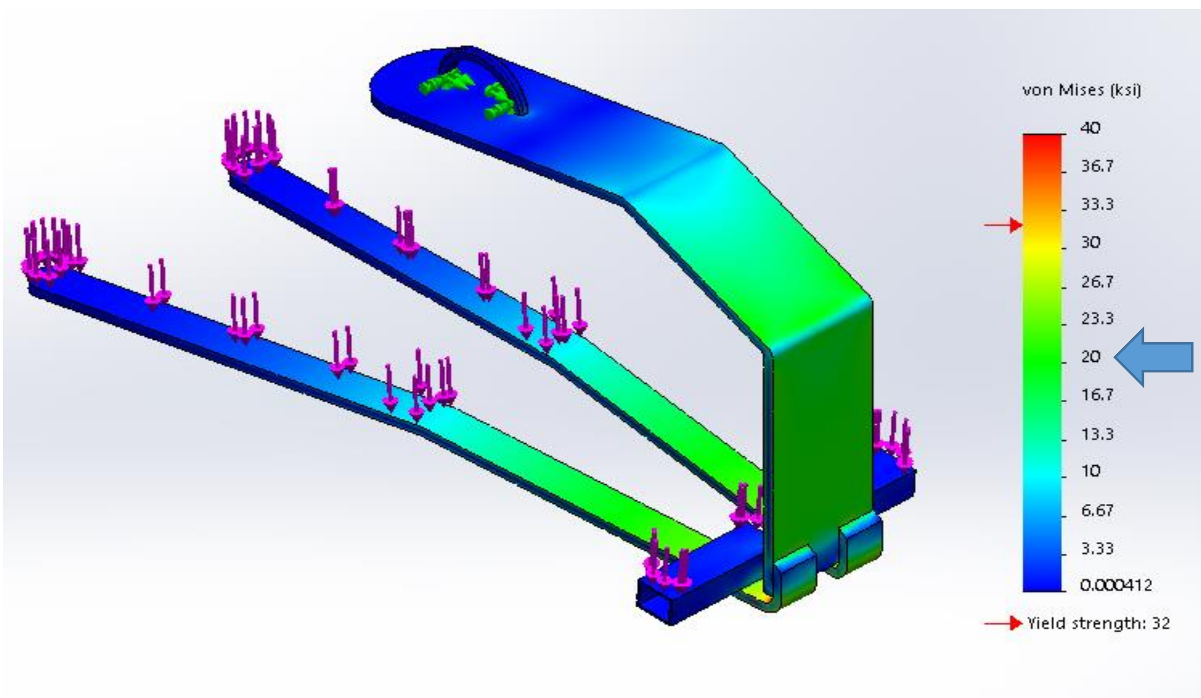
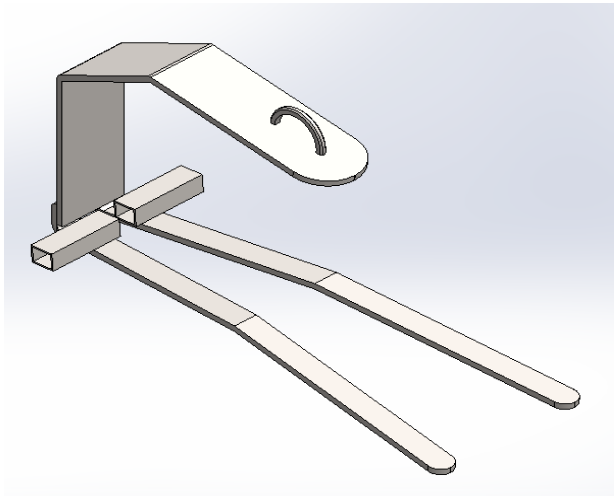
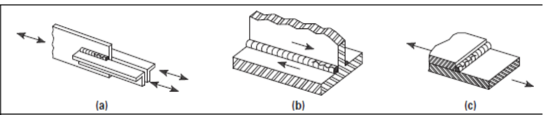
<tr><td>4</td><td>Over 2,000,000</td></tr>
</table></td></tr>
<tr><td>11</td><td>Design Category</td><td>B</td><td>Lifters shall be designed to Design Category B, unless a qualified person determines that Design Category A is appropriate or that Design Category C is required for a special application.</td></tr>
<tr><td>12</td><td>Nominal Design Factor, N_d</td><td>3</td><td>Safety Factor for Static Strength Design</td></tr>
<tr><td>13</td><td>Nominal Design Factor, N_{dd}</td><td>3.6</td><td>The Safety Factor for Connections</td></tr>
<tr><td>14</td><td colspan="3">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).</td></tr>
<tr><td>15</td><td colspan="3">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</td></tr>
</table>

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)	50.0	Weight lifted by device (defined by client on drawings)
18	Job Load, J_{load} (lbs)	110.2	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)	110.2	Job Load
22	Design factor, Df	3	For Structure
23	Applied Force, AF (lbs)	330.60	F x Df
24	Applied Force per Load Point Aft, (lbs)	82.65	AF/4

<table>
<tr><td>25</td><td colspan="3">Apply the load to the Model using Solidworks Simulation</td></tr>
<tr><td>26</td><td colspan="3">
</td></tr>
<tr><td>27</td><td colspan="3">Run the Model</td></tr>
<tr><td>28</td><td colspan="3">
</td></tr>
<tr><td>29</td><td>Max Von Mises Stress, Fm (ksi)</td><td>20.00</td><td>See above</td></tr>
<tr><td>30</td><td>Yield Strength of Material, Fy (ksi)</td><td>36.30</td><td>Mild Steel; assume A36 as worst case mild steel</td></tr>
<tr><td>31</td><td>Safety Factor</td><td>1.82</td><td>Fy/Fm = 1 OK</td></tr>
</table>

<table>
<tr><td>32</td><td colspan="3">Fatigue Analysis</td></tr>
<tr><td>33</td><td colspan="3">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):</td></tr>
<tr><td>34</td><td colspan="3"></td></tr>
<tr><td>35</td><td colspan="3">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 | </td></tr>
<tr><td>36</td><td>Max Rated Load, W_{max} (lbs)</td><td>110.2</td><td>Assumed loading 100% of time</td></tr>
<tr><td>37</td><td>Max Rated Lift Point Load, W_{mc} (lbs)</td><td>27.55</td><td>$W_{max/4}$</td></tr>
<tr><td>38</td><td>Service Class</td><td>3</td><td>Per drawing</td></tr>
<tr><td>39</td><td colspan="3">Table 2-3-1 Service Class
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<tr><th>Service Class</th><th>Load Cycles</th></tr>
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<tr><td>4</td><td>Over 2,000,000</td></tr>
</table></td></tr>
<tr><td>40</td><td>Allowable Stress Range, Fs (ksi)</td><td>9.0</td><td>Table 3-4.3-1, based on Service Class and worst case Stress Category for fatigue</td></tr>
</table>

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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.

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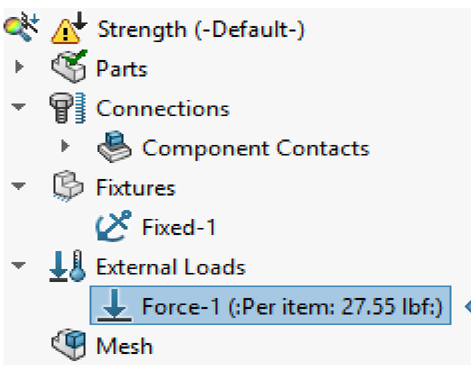

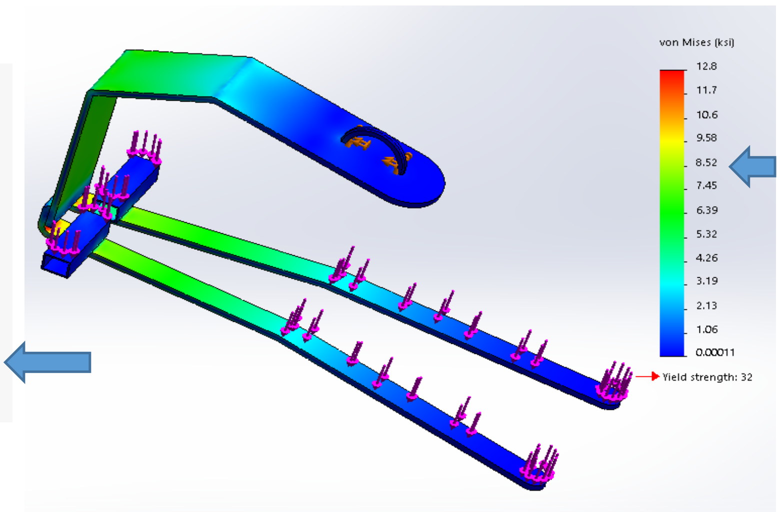

43	Actual Stress, F_a (ksi)	8.52	See above, loading is also a conservative assumption
44	Safety Factor	1.06	$F_s/F_a > 1$ OK

45	**Connection Weld Analysis -Top Lift Tab**		

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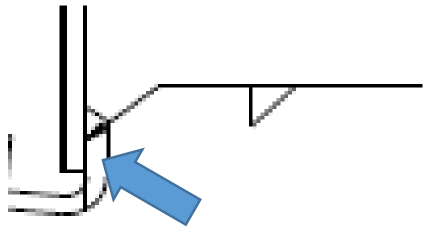

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(b) The design strength of fillet or partial-joint-penetration groove welds subject to shear shall be equal to the effective area of the weld multiplied by the allowable stress F_v given by eq. (3-55). Stresses in the base metal shall not exceed the limits defined in section 3-2.

$$F_v = \frac{0.60Exx}{1.20N_d} \tag{3-55}$$

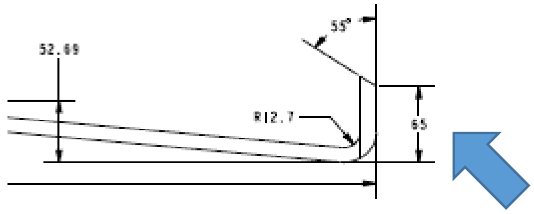
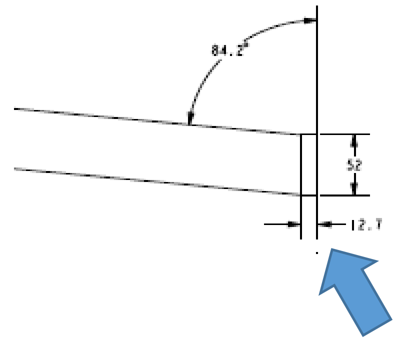
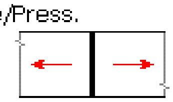
48	Allowable Stress, F_v (ksi)	11.667	See above Eqn. 3-55
49	Nominal Tensile Strength of weld material, E_{xx} (ksi)	70	Typical Value

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 $\frac{1}{4}$ (6)	$\frac{1}{8}$ (3)
Over $\frac{1}{4}$ (6) to $\frac{1}{2}$ (13)	$\frac{3}{16}$ (5)
Over $\frac{1}{2}$ (13) to $\frac{3}{4}$ (19)	$\frac{1}{4}$ (6)
Over $\frac{3}{4}$ (19)	$\frac{5}{16}$ (8)

51	Tensile Load, T_n (kips)	4	Iterative until safety factor met
52	Length of Tab, L (in)	1.92	See below
53	Thickness of Tab, t (in)	-	For weld only on two sides, not all around
54	Length of Fillet Weld, L (in)	3.84	L x 2 + t x 2

55	 		
56	Weld Leg, W_{leg} (in)	0.19	Refer to Table 3-3.4.3-1
57	Nominal Stress on Weld, F_n (ksi)	7.86	See below eqn (area of weld = length x effective throat thickness)
58	**Load** Tensile/Press.  **Rated stress** [MPa, psi] $\sigma_{\perp} = \frac{F_n}{A_w} = \frac{F_n}{L \cdot a}$		a = .707 x Wl
59	Safety Factor	1.48	F_v/F_n > 1 OK