Table 1: The table above contains information regarding the load cells used in the Centro design.

<table>
<thead>
<tr>
<th>Load Cell Data</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Length, $L_{\text{Beam}}$ (in)</td>
<td>11.25</td>
</tr>
<tr>
<td>Height, $h$ (in)</td>
<td>0.25</td>
</tr>
<tr>
<td>Base, $b$ (in)</td>
<td>2</td>
</tr>
<tr>
<td>Modulus of Elasticity, $E$ (psi)</td>
<td>10,000,000</td>
</tr>
<tr>
<td>Yield Strength of Beam, $\sigma_y$ (psi)</td>
<td>8,000</td>
</tr>
</tbody>
</table>

Table 2: This table includes parameters that were calculated by the Centro project team. The values are assuming a 75 kg load on the beam which is being used as the maximum allowable load.

<table>
<thead>
<tr>
<th>Calculated Values</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Force (N)</td>
<td>735.75</td>
</tr>
<tr>
<td>Force, $P$ (lb)</td>
<td>165.54</td>
</tr>
<tr>
<td>Moment of Inertia, $I$ (in^4)</td>
<td>0.00260</td>
</tr>
<tr>
<td>Deflection of Center of Beam, $\delta_{\text{max}}$ (in)</td>
<td>0.01655</td>
</tr>
</tbody>
</table>
SAMPLE CALCULATIONS

CALCULATIONS FOR LOAD CELL

*In order to verify the team’s FEA setup the following calculation was performed to find the deflection of the beam. A load of 75 kg was used. Equations from: Fundamentals of Engineering Supplied-Reference Book, (Clemson, SC: National Council of Examiners for Engineering & Surveying, 2008) 38

\[ F = (75 \text{ kg}) \left( 9.81 \frac{m}{s} \right) \]

\[ F = (735.75 \text{ N}) \left( 0.225 \frac{lb_f}{N} \right) \]

\[ F = 165.54 \text{ lb}_f \]

\[ I = \frac{bh^3}{12} = \frac{(2 \text{ in})(0.25 \text{ in})^3}{12} \]

\[ I = 0.0026 \text{ in}^4 \]

\[ \delta = \frac{FL^3}{48EI} = \frac{(165.54 \text{ lb}_f)(4.5 \text{ in})^3}{48(10 \times 10^6 \text{ psi})(0.0026 \text{ in}^4)} \]

\[ \delta = 0.01207 \text{ in} \]

*To find the maximum stress the strain gage could withstand, the following calculations were completed using the strain gauge’s maximum strain which was 30,000 με.

\[ \sigma = \epsilon E = (30,000 \times 10^{-6} \epsilon)(10 \times 10^6 \text{ psi}) \]

\[ \sigma_{sg max} = 300,000 \text{ psi} \]
*The following calculations are for the max stress experienced by the aluminum bar.

\[ \sigma = \frac{Mc}{I}, \quad I = \frac{bh^3}{12}, \quad c = \frac{h}{2}, \quad M = \frac{FL}{4} \]

\[ \sigma = \frac{6FL}{4bh^2} \]

\[ \sigma = \frac{6(165 \text{ lbs})(4.5 \text{ in})}{4(2\text{ in})((0.25\text{ in})^2)} = 8,910 \text{ psi} \]

FEA = 7,314 psi and MDesign 7,177 psi

Yield = 7,998.6 psi, \quad \text{Factor of Safety} = \frac{(7,998.6 \text{ psi})}{(7,314 \text{ psi})} = 1.1

A higher safety factor is desirable however the team chose to work with the materials provided. For this reason and because the loads may increase the stands were made to be modular so the length of the void may be changed in the future.

The supports for the load experience 82.5 lbs respectively, calculations were not performed for the stress in the supports because it was deemed unnecessary after consulting with professors.
Diagram 1: This diagram shows the Track Width and Wheel base measurements

Diagram 2: This diagram shows the method for determining COGH

**2-D COG**

\[\text{Center of Gravity}_{\text{Wheel Base}} = \left( \frac{\text{Rear Weight}}{\text{Total Weight}} \right) \text{Wheel Base}\]

\[\text{Center of Gravity}_{\text{Track Width}} = \left( \frac{\text{Right Side Weight}}{\text{Total Weight}} \right) \text{Track Width}\]

**COGH**

\[\text{Center of Gravity}_{\text{Height}} = \left( \frac{\text{Wheel Base} \times \Delta \text{Front Weight}}{\text{Total Weight} \times \tan \theta} \right) + \text{tire radius}\]

\[\tan \theta = \frac{\text{Height}}{\text{Wheel Base}}\]
SAMPLE CALCULATIONS

*The following sample calculations are for arbitrary values are in the following table.

<table>
<thead>
<tr>
<th>values in lbs</th>
<th>Front</th>
<th>Rear</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right</td>
<td>65</td>
<td>80</td>
</tr>
<tr>
<td>Left</td>
<td>65</td>
<td>80</td>
</tr>
</tbody>
</table>

\[
Center \ of \ Gravity_{Wheel \ Base} = \left( \frac{160 \ lb}{290 \ lb} \right)65 \ in = 35.8 \ in
\]

\[
Center \ of \ Gravity_{Track \ Width} = \left( \frac{145 \ lb}{290 \ lb} \right)36 \ in = 18 \ in
\]

\[
\tan \theta = \frac{30 \ in}{36 \ in} = 0.8333
\]

\[
Center \ of \ Gravity_{Height} = \left( \frac{65 \times 30}{290 \times 0.83} \right) + 11.5 \ in = 19.5 \ in
\]

11.5 in = includes the radius of the tire and height of the scale

*The following calculations are for converting stain to normal load.

\[
\sigma = \frac{Mc}{I}, \quad I = \frac{bh^3}{12}, \quad c = \frac{h}{2}, \quad M = \frac{FL}{4}
\]

\[
\sigma = \frac{6FL}{4bh^2}, \quad \sigma = \varepsilon E
\]

\[
F = \frac{\varepsilon E(4bh^2)}{6L}
\]