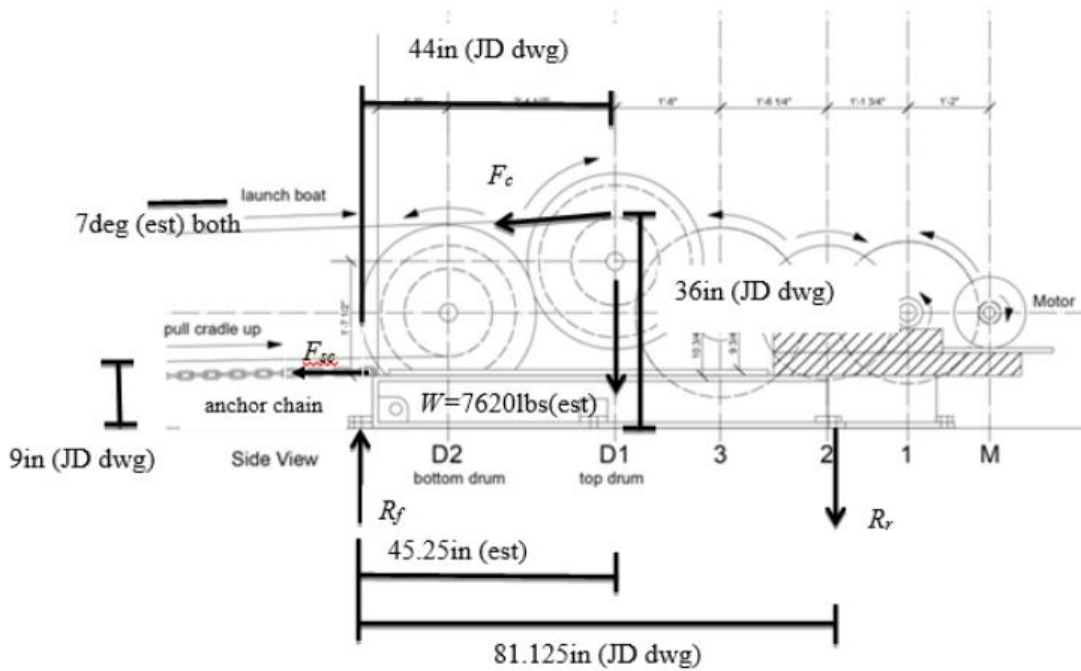FBD

The Free body diagram was used in the analysis to determine the forces acting on the reactions. A standard X-Y coordinate system was used to determine the sign of the forces. Counterclockwise was taken for positive moments and clockwise was used for negative moments.

$$\Sigma F_x: -F_{sc} * \cos(7) - F_c * \cos(7) + R_{fx} + R_{rx} = 0$$

$$\Sigma F_y: -F_{sc} * \sin(7) - F_c * \sin(7) - W + R_{fy} - R_{ry} = 0$$

$$\Sigma M_{R_f}: -(W * 45.25) - (F_{cy} * 44) + (F_{cx} * 36) + (F_{scx} * 9) - (R_{ry} * 81.125) = 0$$

$$R_{fy} = \frac{17933.81}{2} = 8966.905 \; lbf$$

$$R_{ry} = \frac{5439.01}{2} = 2719.505 \; lbf$$

Need to re check equations

Total Length

$$L_t = L_e + T_s + T_n + T_w$$

Where:

Lt = Grip length

Le = Embedment length

Ts = Steel Thickness

Tn = Nut Thickness

Tw = Washer Thickness

The total length required was

Total Length				
L_t (in)	L_e (in)	T_s (in)	T_n (in)	T_w (in)
6.875	4	2	0.75	0.125

Bolt diameter is calculated as

$$\frac{17933.81}{\frac{\pi(d^4)}{4}} = 43511$$

The diameter was calculated as 0.851 inches. A bolt size of 7/8 inches was chosen.

The minimum embedment length was chosen as 4 inches since it is a standard size.

The bolt material was chosen to be Grade 33 Galvanized Steel, with a yield strength of 40000 psi, and a tensile strength of 55000 psi.

The first failure mode was checking the tensile stress of the bolt, this was done by comparing the tensile stress on the bolt to the tensile strength.

The tensile stress and shear stress on the bolt is

$$T_s = \frac{F_t}{A}$$

$$S_s = \frac{F_s}{A}$$

Where:

T_s is the Tensile Stress

F_t is the tensile force

S_s is the shear stress

F_s is the shear force

Stresses on Bolt			
Diameter (in)	Tensile Area (in^2)	T_s (psi)	S_s (psi)
0.250	0.016	1137079.462	629315.541
0.375	0.056	321079.177	177700.964
0.500	0.120	148866.581	82390.067
0.625	0.210	85556.158	47350.974
0.750	0.323	55472.619	30701.268
0.875	0.461	38859.896	21506.972
1.000	0.624	28729.104	15900.095
1.250	1.023	17525.285	9699.352

The table above shows the tensile stresses and shear stress on different bolt sizes.