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Metric Coil Car

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Abstract

Coil cars are a vital part of many steel mills. They allow mills to easily transfer a coil from one location to another without the use of a crane, manual labor, or other extraneous forces. Steel Equipment Specialists, or SES, gets multiple orders every year for coil cars. While the general functions and goals of the cars remains consistent, the details, such as the size of the car, the distance between rails, and the weight/ size of the coils differs between each place. Due to this variety, SES has requested a coil car that can easily be manipulated and produced outside the United States. In the end, a coil car that fit Steel Equipment Specialist's needs, along with a set of calculations, FEAs, and a cost analysis were completed.

The design and completion of the Metric Coil Car would not have been possible without the support of:

Dr. S. Graham Kelly, who contributed time and wisdom as a faculty advisor,

Dr. Dane Quinn for taking the time to read and suggest revisions for the paper, as well as being an honors advisor,

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SES llc., particularly Ian Bowman, for allowing me the opportunity to work on the metric coil car and providing the resources to complete it

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Chapter 1: Introduction

Steel Equipment Specialists (SES) based in Alliance, Ohio is an engineering firm that is committed to building and rebuilding steel equipment. They do large jobs that require multiple machines along with smaller jobs such as frames and platforms. Unlike companies that mass produce products with little customization, SES has a team of engineers who work directly with their customers to meet their needs in a cost-efficient, productive manner. One highly sought-after piece of equipment that SES frequently produces is coil cars.

Coil cars are used in mills where the transportation of coils is necessary. These coils, which often sit on saddles, come in a variety of sizes and weights. In addition, mills are often set up differently, requiring a variety of sizes and shapes, unique for each location. The coil cars run on rails to the location where the coil is sitting on the saddle. The motion is initiated by a motor, controlled by an operator, that is linked to a gear on the drive axle connected by a chain. The platen then raises, due to the force of a cylinder, hoisting the coil above the saddle. The coil car will then travel to a new location along the rails and lower its platen, setting the coil on a new set of saddles.

Steel Equipment specialists have requested a coil car to be made that can be easily adapted to their customer's needs. In addition, they would like to explore getting the car produced in China, as they believe it could save money. The car frame and platen are to be made from A36 steel and the wheels are to run on a rail provided by the customer. In addition, a motor and cylinder must be decided upon.

Chapter 2: Conceptual Design

The purpose of this project is to design a coil car and complete a variety of calculations and analysis on it. The coil car with be used to travel on rails, stop at a specific location, lift an 80,000# coil, travel to another location, and lower the coil. The car should be made using metric units and out of materials available in China. In addition, it should be easily adaptable for uses in different mills. After the design is decided upon, calculations with be ran and a cost analysis will be done.

The main function of the coil car is to transport a coil from one location to another. In order to do this, power, and operator, and hydraulics must be used. Figure 1 shows the basic function diagram, displaying this need for the primary function.

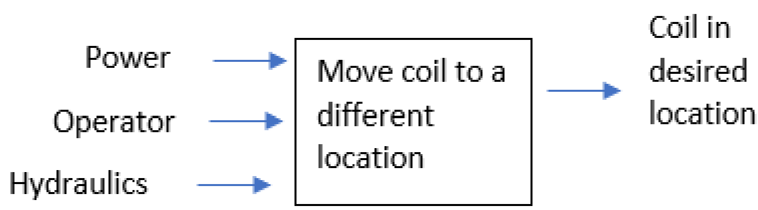


Figure 1: Basic Function Diagram

When the function is further broke down, a better understanding of how the coil car will operate can be seen Figure 2, the expanded function diagram, provides a clear visual for the sequence of events that will occur, along with where the power, operator, and hydraulics come into play.

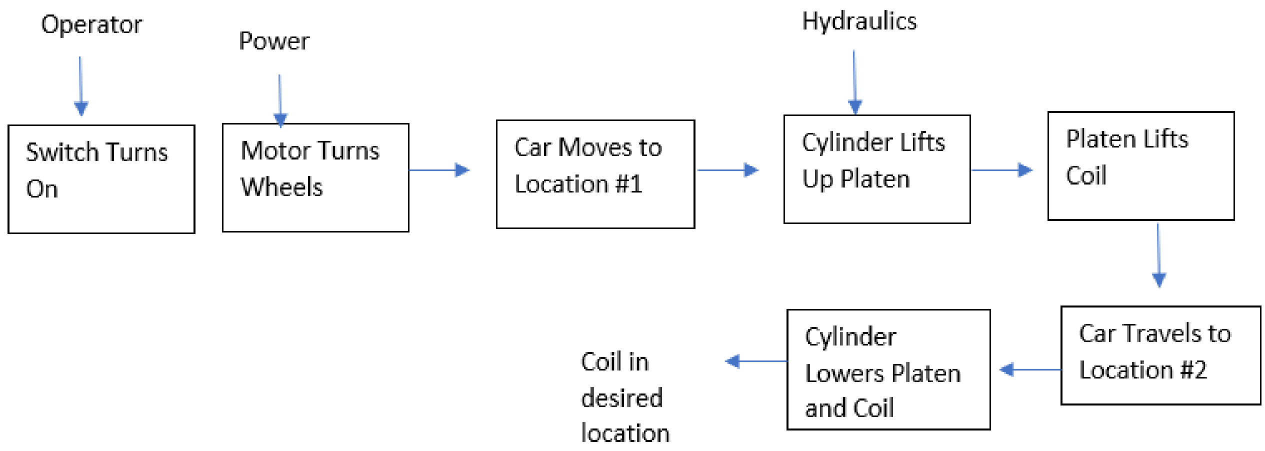
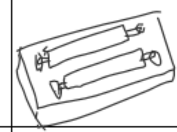
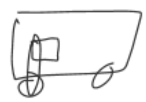
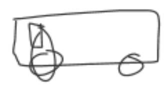
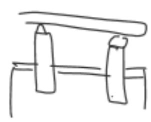


Figure 2: Expanded Function Diagram

These function diagrams will assist when the preliminary designs are created to ensure that all necessary functions can be completed and that there are no unnecessary components being added.

After the necessary function is considered, the beginning stages of visual design can occur. A morphological chart, Table 1, is created to brainstorm and compare ideas for various elements of the coil car. In this case, the platen, car frame, motor, and lifting mechanism were considered.

Table 1: Morphological Chart

	Option 1	Option 2	Option 3	Option 4
Platen	plate w/ saddle on top 3 1 	plate w/ saddle on full plate 	plate w/ two rolls 2 	
Car Frame	open top 1 	closed top 3 2 		
Motor orientation/ location	On top 	On back 3 	on side, horizontal 2 1 	on side, vertical 
Lifting mechanism	scissor lift 2 	Two Cylinders 	One cylinder with guide rods 1 3 	

After the chart was created, I went through and created three combination possibilities to create concept sketches of and consider further. Option 1 consists of a platen with a saddle that does not take up the full plate, an open top frame, the motor oriented horizontal on the side of the car, and one cylinder with guide rods. Option 2 consists of a platen with two rolls, a closed top frame, a motor oriented horizontally on the side of the car, and a scissor lift. Option 3 consists of a platen with a saddle that does not take up the full plate, a closed top, the motor located on the back of the car, and one cylinder with two guide rods. Larger sketches of options 1, 2, and 3 can be seen in Figures 3, 4 and 5, respectively.

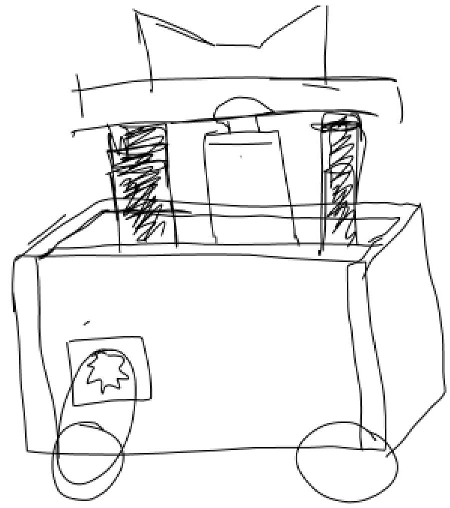


Figure 3: Option One Concept Sketch

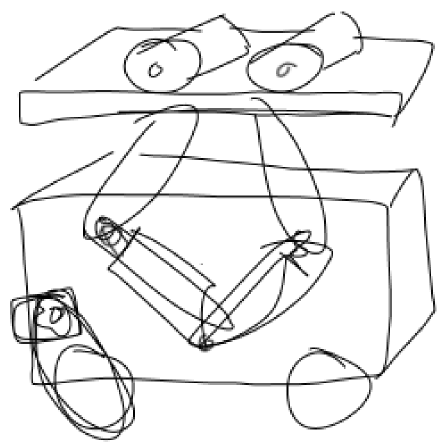


Figure 4: Option Two Concept Sketch

Figure 5: Option Three Concept Sketch

To begin evaluating the quality of each option, Figure 6, an objective tree, was created. The main objective, to create a template coil care for SES was broken down into sub-objectives.

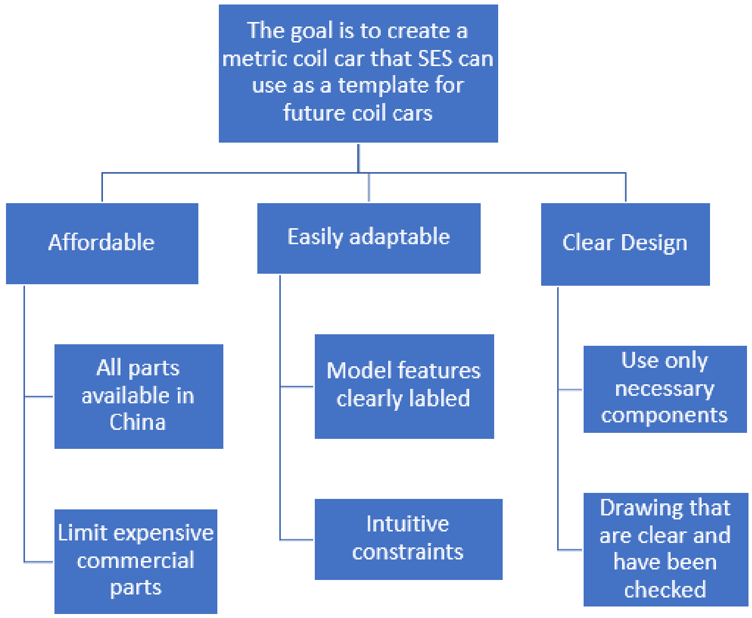


Figure 6: Objective Tree

To see how each design compared, these sub-objectives, along with the time to manufacture an d how often SES thinks they can use that design, were considered. Table 2 is the weighted decision matrix that was used to compare the options

Table 2: Weighted Decision Matrix

	Option 1	Option 2	Option 3
Cost	8	5	7
Frequency design is applicable	6	7	8
Adaptability	8	7	9
Time to manufacture	7	4	6
TOTAL (avg)	7.25	5.75	7.5

Each option was rated for each category on a 10-point scale. The scores were then added up and averaged. Option 3 had the highest score so it will be the design used for the metric coil car.

Chapter 3: Embodiment Design

After the design was decided upon, an initial design was created to showing many components that would be included in the final design. Figure 7 below shows the schematic diagram for the main assembly.

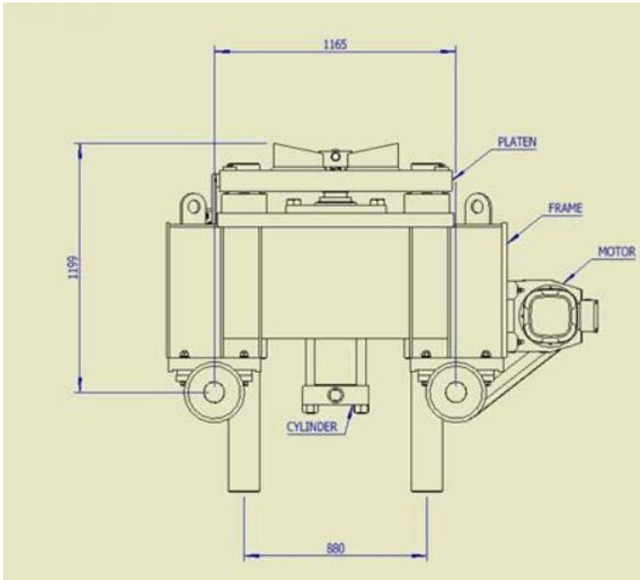


Figure 7: Main Assembly Schematic Diagram

A schematic for the main sub assembly, the drive axle, was also created. Figure 8 displays the drive axle and the orientation that will be used for the final design.

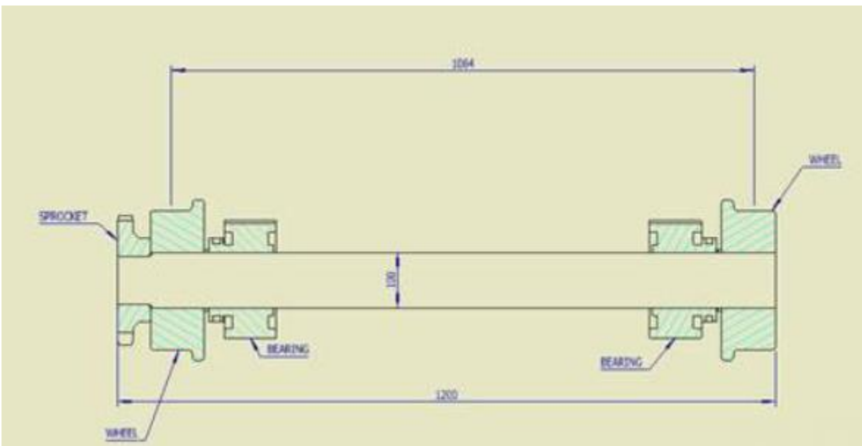


Figure 8: Drive Axle Schematic

A complete model was then created using Inventor 2019 software. The plates will be connected by welding, the platen will be connected to the frame through guide rods and a cylinder, and the drive axle is bolted to the frame through bearings. In addition, the cylinder and motor will be bolted to the frame. To fulfill the embodiment design rule of “clarity of design”, all plates, commercial parts, and connections between parts were necessary to complete the main objective of transporting a coil. To ensure reliability, a full set of calculation and FEA were completed.

Using Inventor 2019 FEA software, an analysis of the frame and the platen was done. A maximum allowable stress on the frame of 10 ksi was used and the force of the cylinder while it lifts the platen and coil, along with the reaction forces form the guide rods and bearings, were included. Tables 3 explains the placement of constraints and Figure 9 shows the set up for the frame FEA, along with the Von Misses stress.

Table 3: Constraint Placement on Frame FEA

Constraint Name	Reaction Force		Reaction Moment	
	Magnitude	**Component (X,Y,Z)**	**Magnitude**	**Component (X,Y,Z)**
Pin Constraint:1	41359.3 lbforce	-3364.77 lbforce	27638.8 lbforce ft	-6.35097 lbforce ft
		41222.2 lbforce		-0.118428 lbforce ft
		0.716351 lbforce		27638.8 lbforce ft
Pin Constraint:2	41273.8 lbforce	3364.29 lbforce	27802.8 lbforce ft	82.6503 lbforce ft
		41136.4 lbforce		-0.0277737 lbforce ft
		1.1332 lbforce		-27802.7 lbforce ft
Frictionless Constraint:1	1792.58 lbforce	-0.00338643 lbforce	193.297 lbforce ft	6.62597 lbforce ft
		1792.58 lbforce		0.00103577 lbforce ft
		-0.0207577 lbforce		193.183 lbforce ft

⊟ **Von Mises Stress**

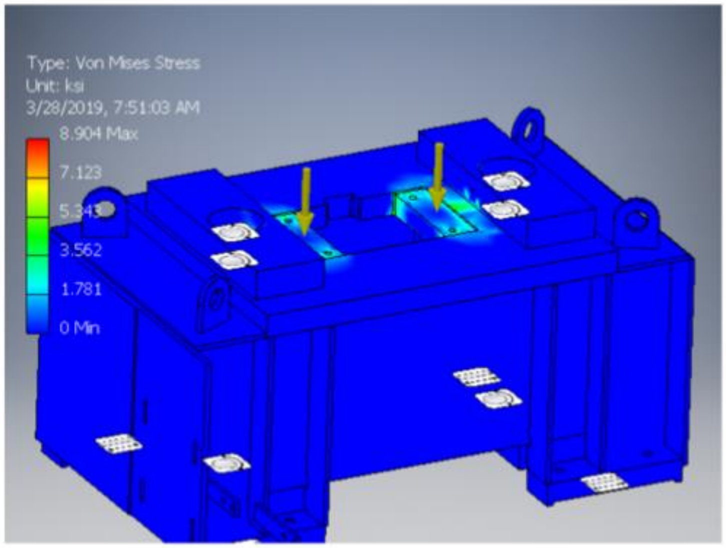


Figure 9: Frame FEA

The highest stress that occurred was where the cylinder sits with a magnitude of 3.9 ksi which is far below the max of 10 ksi.

An FEA was ran for the platen as well. Forces were placed to represent the weight of the coil, along with the reaction force of the cylinder and guide rods. Table 4 shows the placement of the constraints and Figure 10 shows the Von Misses stress on the platen with a max of 10 ksi.

Table 4: Constraint Placement on Platen FEA

Constraint Name	Reaction Force		Reaction Moment	
	Magnitude	Component (X,Y,Z)	Magnitude	Component (X,Y,Z)
Pin Constraint:1	25301.4 lbforce	11193 lbforce	6923.54 lbforce ft	0 lbforce ft
		22690.9 lbforce		0 lbforce ft
		0 lbforce		6923.54 lbforce ft
Pin Constraint:2	25305 lbforce	-11192.5 lbforce	6925.65 lbforce ft	0 lbforce ft
		22695.2 lbforce		0 lbforce ft
		0 lbforce		-6925.65 lbforce ft
Frictionless Constraint:1	34968.8 lbforce	0 lbforce	6.65156 lbforce ft	-5.3023 lbforce ft
		34968.8 lbforce		0 lbforce ft
		0 lbforce		-4.01608 lbforce ft

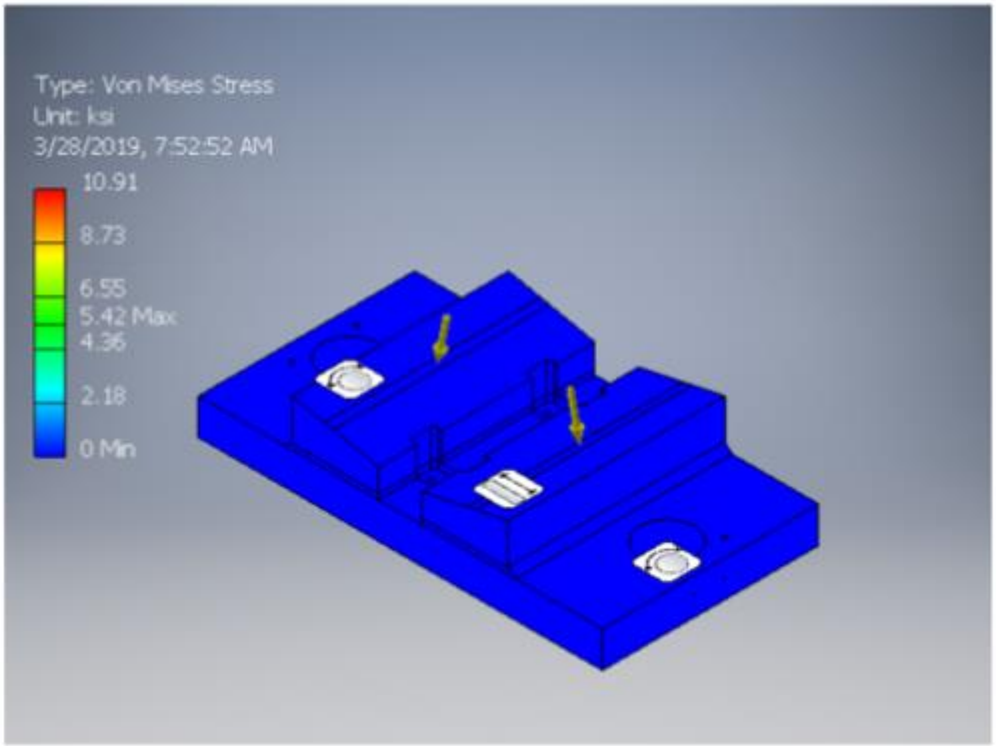


Figure 10: Frame FEA

No stresses exceeded 2 ksi, which is far below the maximum allowable stress of 10 ksi.

For the frame and platen, A36 steel will be used since the stresses on the frame are low enough that this affordable and easily acquirable steel will be effective. For the guide rods, a stronger steel, like 1045 TG&P will be used since there will be more force put on the guide rods. The holes for the guide rod, along with the seats for the cylinder and motor will be machined for a smooth finish. The saddle where the coil will sit will also have a smooth finish to prevent damage to the coil.

Numerous calculations had to be done to ensure that the design was feasible and to aid in the selection of commercial parts and the selection of the appropriate sizes for manufactured parts.

Prior to selecting a motor, the force needed to accelerate the car had to be determined. Using Equation 1 the total force needed was found to be 2301.1 lbs.

$$\frac{Load * acc}{g} + \left(\frac{Load}{2000\#/ton} + \frac{20\#}{ton}\right)$$

Equation 1: Force Needed to Accelerate Car

The necessary power, torque, and speed can then be found using Equation 2, 3, and 4, respectively.

$$P = \frac{F * velocity}{33{,}000} * eff$$

Equation 2: Power Needed to Accelerate Car

$$T = F * r_{wheel}$$

Equation 3: Torque Needed to Accelerate Car

$$n = \frac{velocity}{2.62(D_{wheel})}$$

Equation 4: Speed Needed to Accelerate car

The power needed is 5.9 HP (4.4 KW). The torque needed is 11505 in# (or 1299.9 Nm) and the speed needed is 34.4 RPM. According to the SEW catalog (SEW), motor with part number R97DRN132M4 has a speed of 40 RPM, torque of 1810 Nm, and power of 7.5 KW.

When calculating the motor power and torque, a wheel diameter of 10" was assumed. To ensure that this was a valid assumption, the force on each wheel was found. The maximum force each wheel would be subjected to was found to be 22,538#. Figure 11 displays the free body diagram that was used to determine the force on each wheel.

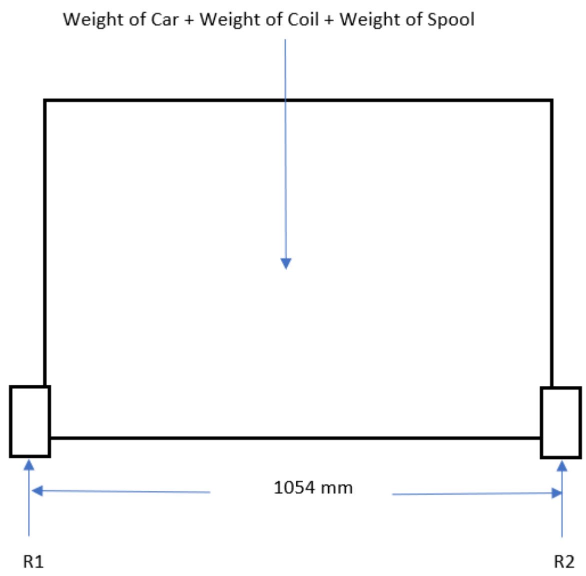


Figure 11: Wheel Free Body Diagram

The wheels, which will have a hardness of 320 BHN, can withstand a force of 24,350# ("Brinell hardness (HB), Rockwell hardness (HRC) and Vickers hardness (VH)"). Therefore, they will be able to withstand the subjected load.

Next, a chain to connect the motor and drive axle must be selected. Using Equation 5 and assuming a pitch diameter 0f 7.313", the force the chain needs to withstand is 47,187#.

$$F_{chain} = S.F. * \frac{T_{motor}}{Pitch\ Diameter/2} * 10$$

Equation 5: Force Exerted on Chain

According to the Browning catalog ("Roller Chain Sprockets"), a 160 single strand chain with a pitch of 2" can withstand 58,000#. This is the chain that will be used for the coil car. To determine the sprockets that will be used on the axle and motor, the Browning catalog was used ("Roller Chain Sprockets"). The motor will use a 160B13 sprocket which has a pitch diameter of 8.357". Using Equation 5, the new chain force was found to be 41,337# which is within the

allowable range. The sprocket for the motor will have 13 teeth and the sprocket for the drive axle will have 16 teeth.

To select the bearings used to hold up the axles, the maximum wheel force of 22,538# was used. Timken bearings QMPL20J100SET/ QMPL20J100SET are able to withstand this load. Using Equation 6, the bearing life is estimated to be 61,496 hours which surpasses the 5 year, or 43,800 hour life that was desired.

$$L_{10} = \left(\frac{dynamic\ capacity}{F}\right)^{10/3} * \frac{16667}{RPM}$$

Equation 6: Life of Bearing

Finally, the cylinder must be selected. The cylinder must be able to overcome the combined weight of the platen, coil, and spool which is estimated to be 84,150#. Using a pressure of 1500 psi and Equation 7, a 10" bore cylinder will be the most cost efficient selection that will withstand the force exerted on it.

$$F = P * A$$

Equation 7: Cylinder Force

A 10" bore at 1500 psi is capable of 117,809# of force. Parker cylinder 254CJ2HRL29MC610.00M1100 will best suit the coil car.

Chapter 4: Detail Design

After the embodiment design process is complete, a more thorough and complete analysis of the coil car components must be completed. The guide rods, which ensure the platen does not tilt or turn are a vital part of the coil car design; without them, the platen could become unstable and the coil could fall. Figure 12 shows the free body diagram for the guide rods where the forced is acting on one contact point between the coil and platen (worst-case scenario) and reaction forces occur where the guide rods meet the bearing.

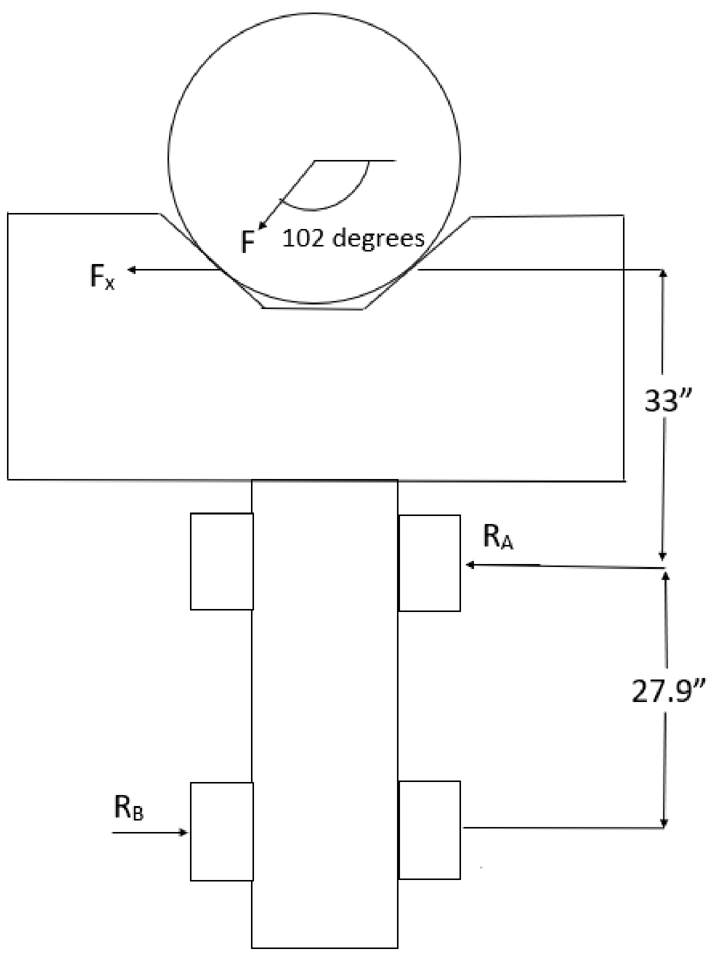


Figure 12: Guide Rods Free Body Diagram

By setting F_x equal to 1291#, summing the moments, and setting the sum equal to zero, R_A is found to be 1274# and R_B= 754#. Therefore, the max force acting on the guide rods will be the force form the coil, or F_x. Using Equation 8, the max stress from bending on the guide rods is 1057 psi.

$$\sigma = \frac{M}{s}$$

Equation 8: Bending Stress

Using 1045 HR, the maximum stress allowable is 15,000 psi (“1045 Hot Rolled”). Thus the guide rods will be suitable for the coil car.

In addition to the FEA preformed during embodiment design, calculations must be performed on the platen to ensure the plate is thick enough to support the weight of the coil. Figure 13 shows the set up for the free body diagram for the platen.

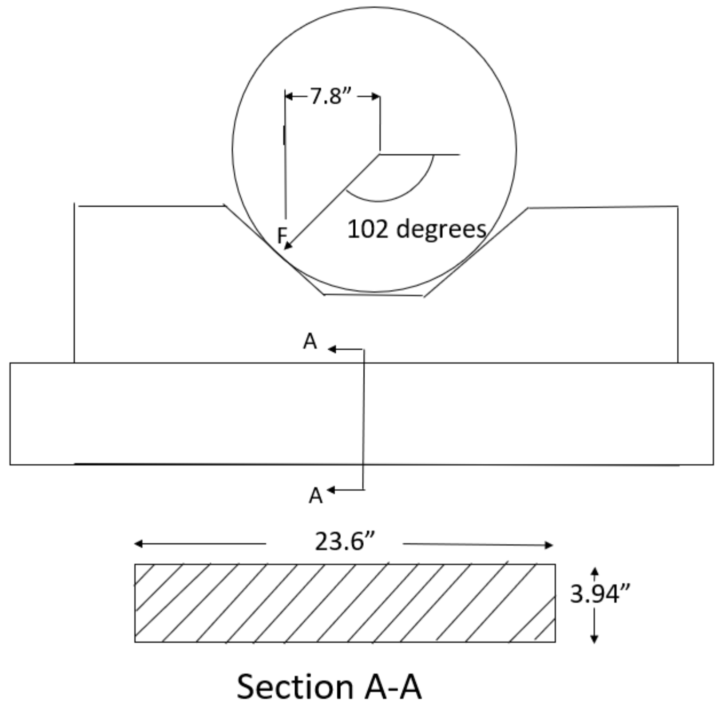


Figure 13: Platen Free Body Diagram

The area of the cross section and the section modulus are calculated using Equation 9 and Equation 10, respectively.

$$A = w * h$$

Equation 9: Cross Section Area

$$s = \frac{w * h^2}{6}$$

Equation 10: Section Modulus

Then, setting the shear force, or v, equal to 41,075# (total force/2) and the moment equal to 320,385#in (v*7.8”), the shear stress is found using Equation 11 and the bending stress is found using Equation 8

$$T = \frac{v}{A}$$

Equation 11: Shear Stress

The total stress is calculated using Equation 12 and comes out to be 5298 psi, which is below the allowable stress of 11,500 psi (Crooks).

$$\sigma_{comb} = \sqrt{\sigma^2 + 3 * (T^2)}$$

Equation 12: Combined Stress

The drive axle must also be evaluated. Figure 14, the drive axle free body diagram, shows the location of the forces. The magnitudes of the forces were found previously.

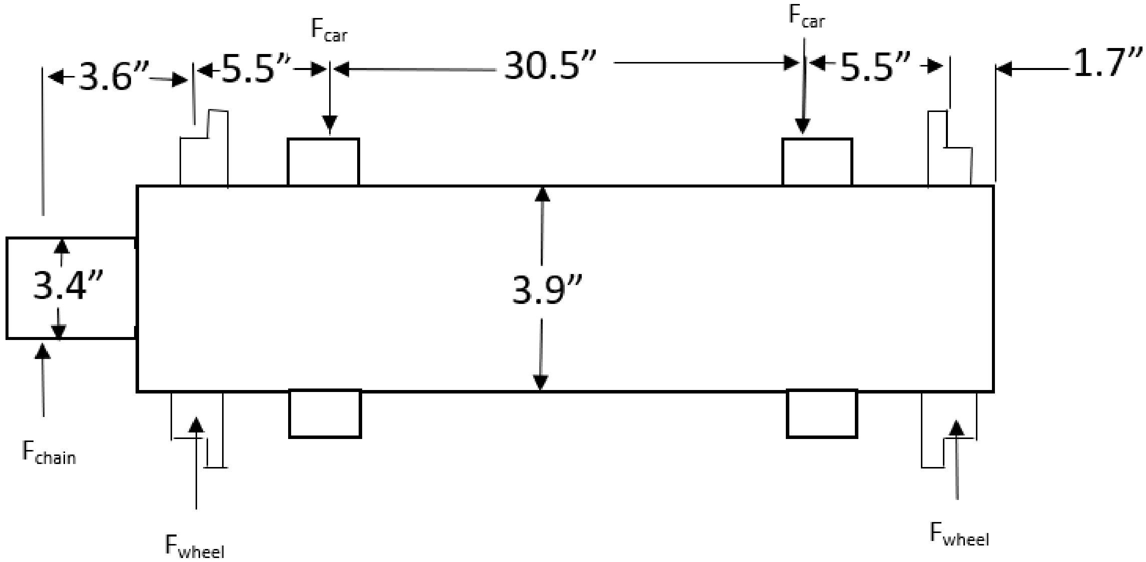


Figure 14: Drive Axle Free Body Diagram

The critical points on the shaft that will be evaluated are the bearing (9.1" from the left) and the step between the 3.4" diameter and 3.9" diameter. Using Beam Guru (X), the shear force, moment, and torque can be found. Then, using Equations 13 and 8, the shear stress 3121 psi and the bending stress is 23746 psi.

$$T_{shear} = \frac{4}{3} * \frac{v}{A} + \frac{16T}{\pi * d^3}$$

Equation 13: Shear Stress Using Shear Force

Using Equation 12, the combined stress is 24353 psi. Using 4140 Q&T, the max allowable stress is 30,600 psi, so the axle should not fail at the bearing. At the step, the shear stress concentration factor is K_t=1.9 and the bending stress concentration factor is K_b=2.3 ("Stress Concentration Factors"). Modifying Equation 13 to get Equation 14, T_{shear}=3156 psi.

$$T_{shear} = \frac{4}{3} * \frac{v}{A} + \frac{16T * k_t}{\pi * d^3}$$

Equation 14: Shear Stress Using Shear Force with Stress Concentration

Modifying Equation 8 to include the bending stress concentration factor, Equation 15 gives the bending stress at the shoulder to be 3900 psi.

$$\sigma = \frac{M * k_b}{s}$$

Equation 15: Bending Stress with Stress Concentration

The combined stress, found using Equation 12, is 6714 psi, which is well below the allowable stress of 30,600 psi.

With all calculation completed, the model is able to be finalized and drawings can be completed. The assembly drawing can be seen in Figures 15 and 16. Dimensions and views have been excluded for confidentiality purposes.

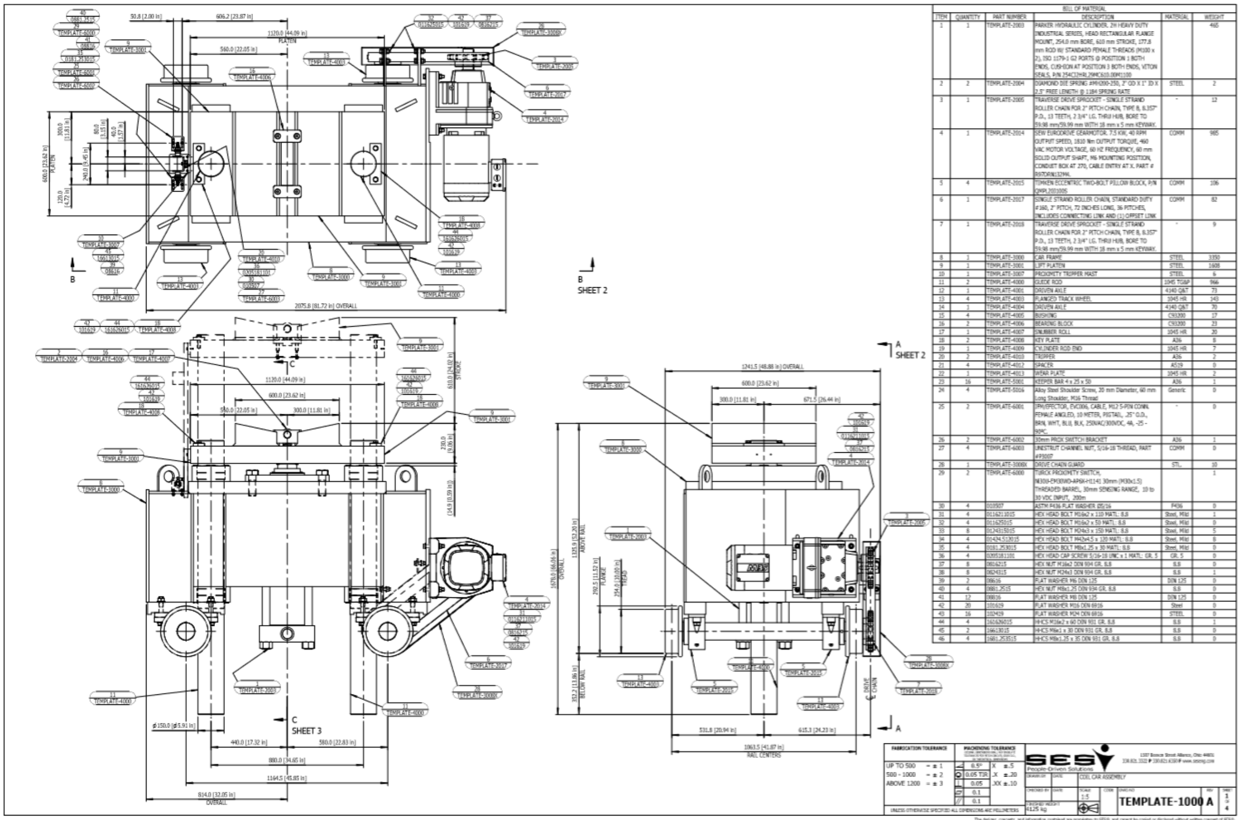


Figure 15: Assembly Drawing Sheet 1

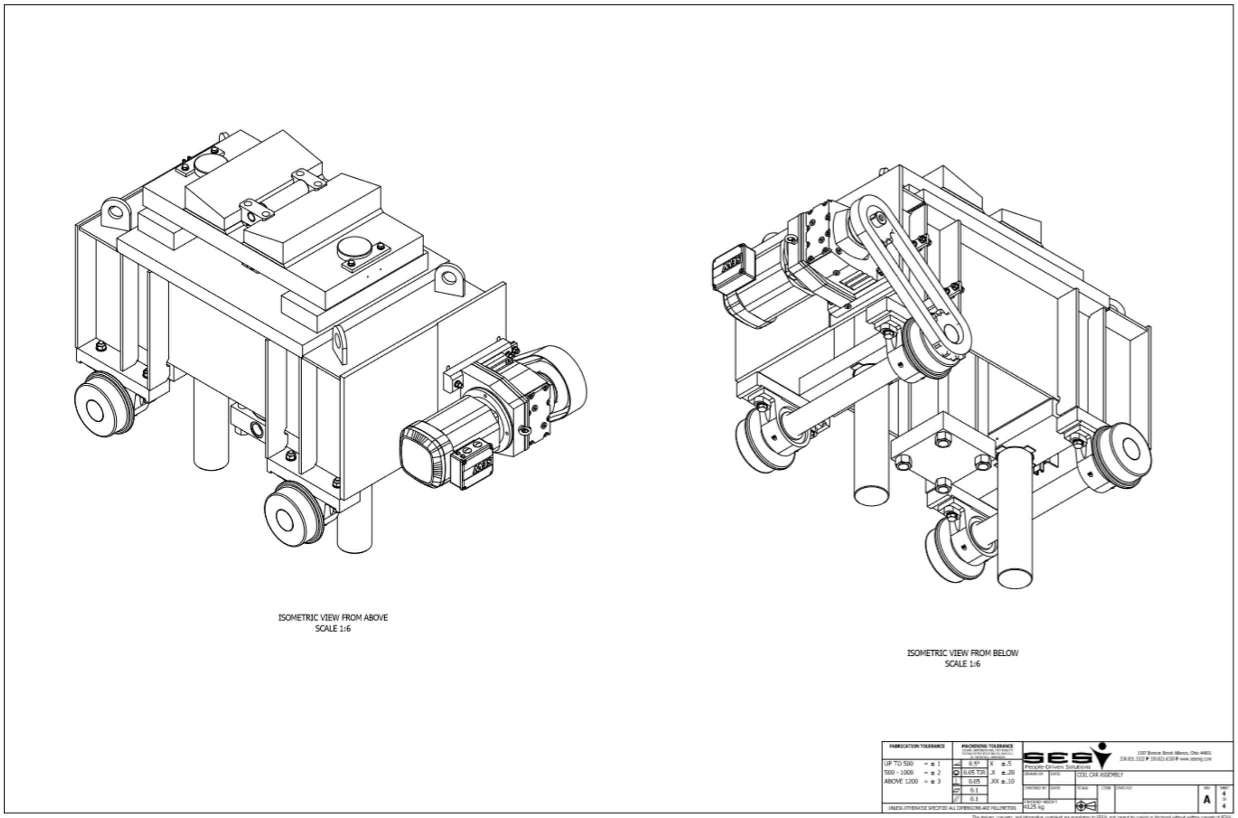


Figure 16: Assembly Drawing Sheet 4

The first page of the frame drawing can be seen in Figure 17.

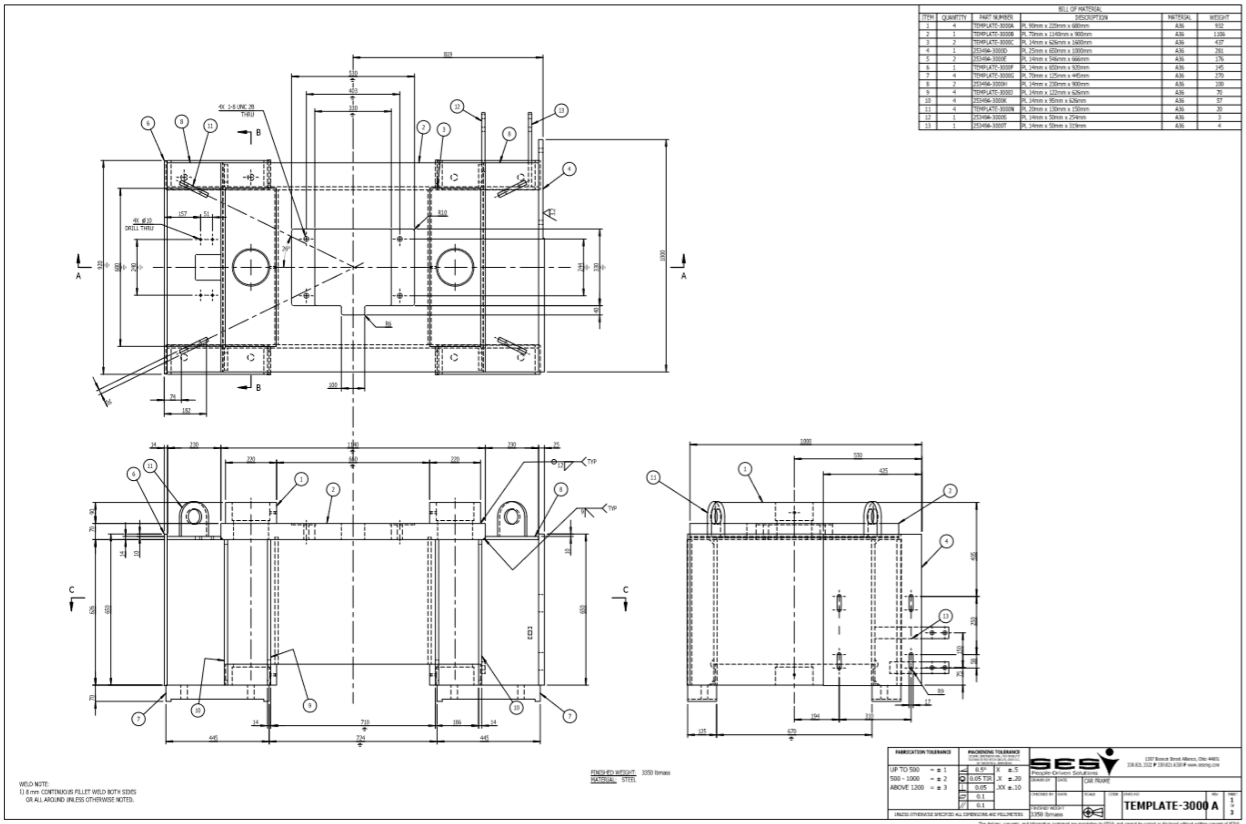


Figure 17: Frame Detail Sheet 1

Drawing were created for all other manufactured parts but have been excluded for confidentiality purpose. As seen in Figures 15, 16, and 17, welds, machining, and tolerancing are included in the drawings to ease manufacturing.

Based on the Bill of Materials seen in Figure 18, the cost for the metric coil car made in China will be roughly 21,000 USD.

BILL OF MATERIAL					
ITEM	QUANTITY	PART NUMBER	DESCRIPTION	MATERIAL	WEIGHT
1	1	TEMPLATE-2003	PARKER HYDRAULIC CYLINDER. 2H HEAVY DUTY INDUSTRIAL SERIES, HEAD RECTANGULAR FLANGE MOUNT, 254.0 mm BORE, 610 mm STROKE, 177.8 mm ROD W/ STANDARD FEMALE THREADS (M100 x 2), ISO 1179-1 G2 PORTS @ POSITION 1 BOTH ENDS, CUSHION AT POSITION 3 BOTH ENDS, VITON SEALS, P/N 254CJ2HRL29MC610.00M1100		465
2	2	TEMPLATE-2004	DIAMOND DIE SPRING #MH200-250, 2" OD X 1" ID X 2.5" FREE LENGTH @ 1184 SPRING RATE	STEEL	2
3	1	TEMPLATE-2005	TRAVERSE DRIVE SPROCKET - SINGLE STRAND ROLLER CHAIN FOR 2" PITCH CHAIN, TYPE B, 8.357" P.D., 13 TEETH, 2 3/4" LG. THRU HUB, BORE TO 59.98 mm/59.99 mm WITH 18 mm x 5 mm KEYWAY.	-	12
4	1	TEMPLATE-2014	SEW EURODRIVE GEARMOTOR. 7.5 KW, 40 RPM OUTPUT SPEED, 1810 Nm OUTPUT TORQUE, 460 VAC MOTOR VOLTAGE, 60 HZ FREQUENCY, 60 mm SOLID OUTPUT SHAFT, M6 MOUNTING POSITION, CONDUIT BOX AT 270, CABLE ENTRY AT X. PART # R97DRN132M4.	COMM	985
5	4	TEMPLATE-2015	TIMKEN ECCENTRIC TWO-BOLT PILLOW BLOCK, P/N QMPL20J100S	COMM	106
6	1	TEMPLATE-2017	SINGLE STRAND ROLLER CHAIN, STANDARD DUTY #160, 2" PITCH, 72 INCHES LONG, 36 PITCHES, INCLUDES CONNECTING LINK AND (1) OFFSET LINK	COMM	82
7	1	TEMPLATE-2018	TRAVERSE DRIVE SPROCKET - SINGLE STRAND ROLLER CHAIN FOR 2" PITCH CHAIN, TYPE B, 8.357" P.D., 13 TEETH, 2 3/4" LG. THRU HUB, BORE TO 59.98 mm/59.99 mm WITH 18 mm x 5 mm KEYWAY.	-	9
8	1	TEMPLATE-3000	CAR FRAME	STEEL	3350
9	1	TEMPLATE-3001	LIFT PLATEN	STEEL	1608
10	1	TEMPLATE-3007	PROXIMITY TRIPPER MAST	STEEL	6
11	2	TEMPLATE-4000	GUIDE ROD	1045 TG&P	966
12	1	TEMPLATE-4001	DRIVEN AXLE	4140 Q&T	73
13	4	TEMPLATE-4003	FLANGED TRACK WHEEL	1045 HR	143
14	1	TEMPLATE-4004	DRIVEN AXLE	4140 Q&T	70
15	4	TEMPLATE-4005	BUSHING	C93200	17
16	2	TEMPLATE-4006	BEARING BLOCK	C93200	23
17	1	TEMPLATE-4007	SNUBBER ROLL	1045 HR	20
18	2	TEMPLATE-4008	KEY PLATE	A36	8
19	1	TEMPLATE-4009	CYLINDER ROD END	1045 HR	7
20	2	TEMPLATE-4010	TRIPPER	A36	2
21	4	TEMPLATE-4012	SPACER	A519	0
22	1	TEMPLATE-4013	WEAR PLATE	1045 HR	2
23	16	TEMPLATE-5001	KEEPER BAR 4 x 25 x 50	A36	1
24	4	TEMPLATE-5016	Alloy Steel Shoulder Screw, 20 mm Diameter, 60 mm Long Shoulder, M16 Thread	Generic	0
25	2	TEMPLATE-6001	IFM/EFECTOR, EVC006, CABLE, M12 5-PIN CONN. FEMALE ANGLED, 10 METER, PIGTAIL, .25" O.D., BRN, WHT, BLU, BLK, 250VAC/300VDC, 4A, -25 - 90ºC.	-	0
26	2	TEMPLATE-6002	30mm PROX SWITCH BRACKET	A36	1
27	4	TEMPLATE-6003	UNISTRUT CHANNEL NUT, 5/16-18 THREAD, PART #P3007	COMM	0
28	1	TEMPLATE-3008X	DRIVE CHAIN GUARD	STL.	10
29	2	TEMPLATE-6000	TURCK PROXIMITY SWITCH, NI30U-EM30WD-AP6X-H1141 30mm (M30x1.5) THREADED BARREL, 30mm SENSING RANGE, 10 to 30 VDC INPUT, 200m		1
30	4	010507	ASTM F436 FLAT WASHER Ø5/16	F436	0
31	4	0116211015	HEX HEAD BOLT M16x2 x 110 MATL: 8.8	Steel, Mild	1
32	4	011625015	HEX HEAD BOLT M16x2 x 50 MATL: 8.8	Steel, Mild	0
33	8	0124315015	HEX HEAD BOLT M24x3 x 150 MATL: 8.8	Steel, Mild	5
34	4	01424.512015	HEX HEAD BOLT M42x4.5 x 120 MATL: 8.8	Steel, Mild	8
35	4	0181.253015	HEX HEAD BOLT M8x1.25 x 30 MATL: 8.8	Steel, Mild	0
36	4	0205181101	HEX HEAD CAP SCREW 5/16-18 UNC x 1 MATL: GR. 5	GR. 5	0
37	8	0816215	HEX NUT M16x2 DIN 934 GR. 8.8	8.8	0
38	8	0824315	HEX NUT M24x3 DIN 934 GR. 8.8	8.8	1
39	2	08616	FLAT WASHER M6 DIN 125	DIN 125	0
40	4	0881.2515	HEX NUT M8x1.25 DIN 934 GR. 8.8	8.8	0
41	12	08816	FLAT WASHER M8 DIN 125	DIN 125	0
42	20	101619	FLAT WASHER M16 DIN 6916	Steel	0
43	16	102419	FLAT WASHER M24 DIN 6916	STEEL	0
44	4	161626015	HHCS M16x2 x 60 DIN 931 GR. 8.8	8.8	1
45	2	16613015	HHCS M6x1 x 30 DIN 931 GR. 8.8	8.8	0
46	4	1681.253515	HHCS M8x1.25 x 35 DIN 931 GR. 8.8	8.8	0

Figure 18: Bill of Materials

Chapter 5: Discussion

Creating the coil car required a multitude of different design considerations and analysis. The necessity of calculations to ensure failure would not occur became very evident as well as the need for clarity of design by specifying machining, tolerancing, and finishes.

After creating the model and drawings, the cost of the metric coil car was able to be estimated at approximately 21,000 USD. A similar car produced in the United States cost approximately 24,000 USD. While at first glance, it may seem like producing the car in China is the optimal optional, other factors must also be considered. If the car is produced for a company in the United States, like it typically is for SES, shipping costs along with tariffs could possibly make the coil car produced in China the lesser option. Further consideration must be made on a case-to-case basis.

Chapter 6: Conclusions

Steel Equipment Specialists in Alliance, Ohio produce multiple coil cars every year. Now, with the metric coil car template available to them, the time it takes to design and produce a coil car can be greatly lessened. In addition, there is a framework for the possibility of getting the coil car manufactured in China.

In the future, further analysis can be done to evaluate if, including shipping and tariffs, the metric coil car produced in China is more likely to be a better option. However, for now, the coil cars that SES produces every year can be made in a timelier fashion.

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