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Speed Bump Power Generator

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By

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SPEED PUMP POWER GENERATOR

1. INTRODUCTION

A. DESCRIPTION:

A large amount of energy is wasted by the vehicles on the speed breakers through friction, every time it passes over it. Energy can be produced by using the vehicle weight and speed. So, the team will propose a smart speed breaker that generates power. The reciprocating motion of the speed breaker is converted into rotary motion using the rack and pinion arrangement. The team will design a smart speed pump that can pass vehicles coming from both sides and yet generate energy from it. The system makes use of mechanical assembly with metal sheets with linkages that press down with spring arrangement. The system makes use of the speed breaker press and then uses a rack and pinion arrangement to press down and run generator motor thus generating energy. The spring mechanism is used to drive the speed breaker back into the original position.

B. MOTIVATION:

There are a great number of jobs and places to visit in big cities. These factors cause traffic congestion on roads which can be taken advantage of. Speed Pump power generator can be placed in places that are crowded to generate electricity for the area. When there are vehicles motion, Speed Pump Power Generator will be able to generate power for the area.

C. FUNCTION STATEMENT:

The Function of this project is to generate power provided by vehicles motion.

D. REQUIREMENTS

- The hydraulic system must move up and down at least in no more than 4 seconds per stroke.
- The project must generate at least 10 Watts per stroke.

● The project must generate the power for at least 3 seconds per stroke.

● The Project must Store Energy 50 Amp/H.

● The dimension must be about 600*400*600 mm.

● The project must endure a vehicle of 5000 lb.

● The project must be easy for maintenance.

● The project should weight no more than 30 lb.

● The top plate must turn to the first position in no more than 5 seconds.

E. SUCCESS CRITERIA:

- The project should meet all the safety requirements.
- The project should not have noise.
- The project should have low weight.

F. SCOPE OF EFFORT:

The project will use a DC motor that is any of rotary electrical machines that converts direct current electrical energy into mechanical energy.

● The project would be very successful if it generates electricity from vehicle motion and store the power to be used in the least crowded times.

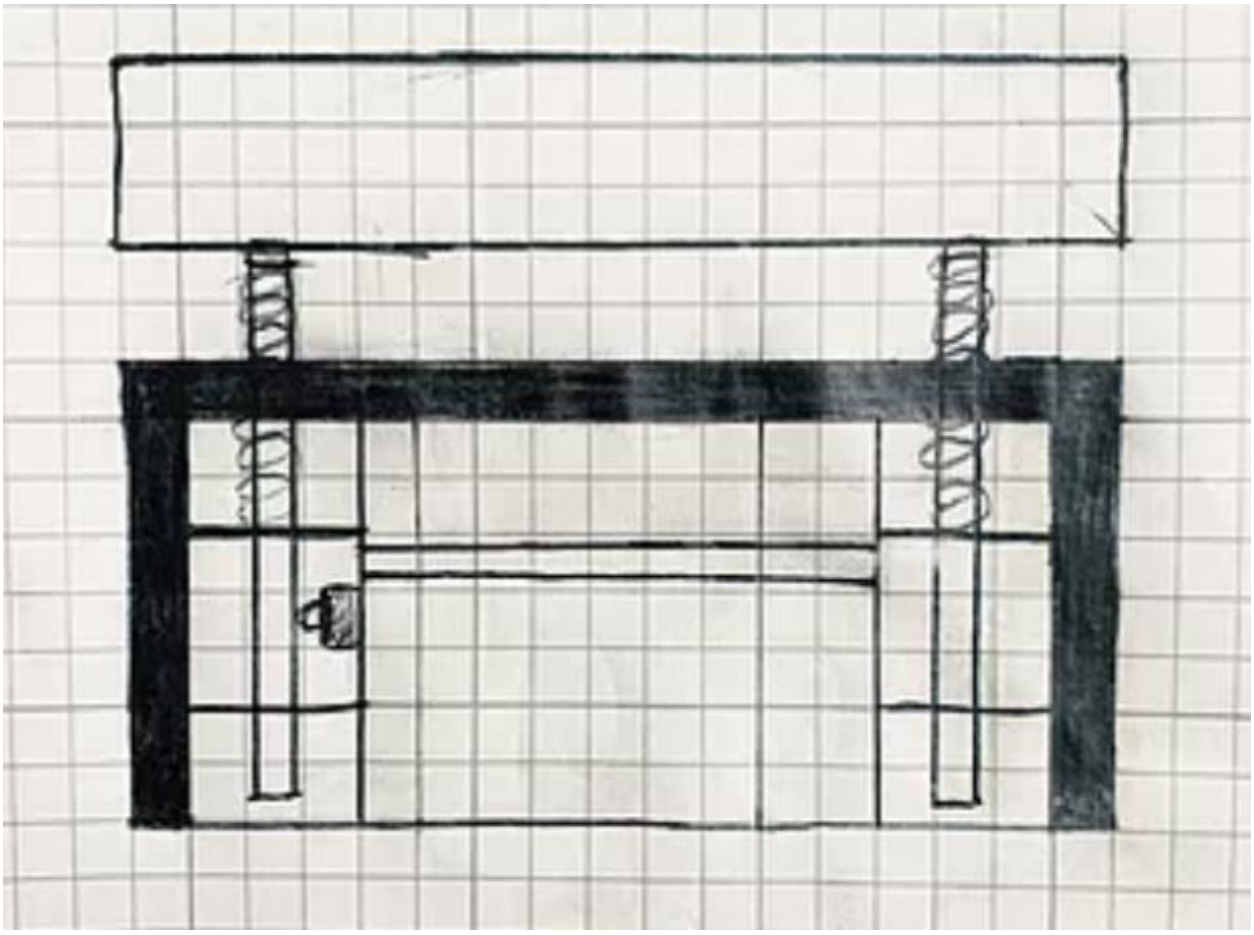
2. DESIGN AND ANALYSES:

A. APPROACH: PROPOSED SOLUTION:

The design and analyses are presented at appendix A, and the solid works design and dimensions are represented at appendix B. The analyses contain only about Structure. The design will perform efficiently when all of the dimensions, loads, and requirements are met properly.

Basically, the speed pump is a feature that reduces speed in order to minimize traffic and while reducing the speed through vertical deflection mechanism. The speed pump is a system which operates deflection mechanism with a plain piece installed on the way of the road at a determined slope and height. Mostly the gradient and the height range from 3 to 4 inches. The mechanism depth I basically buried in about one foot while contrasting with 10 to 14 feet width. The construction could however be constructed in various sizes depending on the size of the road where installation will be done. Also, the machine can be installed on the road adapting pairs of four to six feet. The device may also be separated side by side on the road while observing the lowest slope facing on the impending traffic and then connected across the surface of the road. The speed bump generator is sometimes constructed to perform two functions, apart from the road safety it can be used to produce huge amount of electricity from the concept of generator. The power produced then utilized in lighting. The advantage of this design is to be environmentally friendly and cost effective in the in the long term. In addition, the construction materials are readily available. The construction of Speed Pump Power Generator does not require expensive materials and high technology. The generation of this type of power is not dependent on the weather conditions but rather the movement of vehicles. Therefore, it works throughout the year once installed. The maintenance cost is also low.

B. DESIGN DESCRIPTION: (.JPG)



C. BENCHMARK:

Solar Energy relies on sunny whether to convert the sun's energy into electricity. The Mechanical Speed Pump Power Generator relies on cars motion, which means that the project must be placed on the roads that are crowded most of the year.

D. PERFORMANCE PREDICTION:

The performance of the project will be as described below:

a. The speed bump will generate electricity provided by cars' motion.
b. Springs will take 3 seconds to return to the original position.
c. The speed bump will endure a load of 250 lb.

D. DESCRIPTION OF ANALYSES:

Analyses are presented in appendix A.

E. SCOPE OF TESTING AND EVALUATION:

Mechanical testing includes testing each part of the machine/robot individually followed by the complete testing after which the project is ready to be used.

3. METHODS AND CONSTRUCTION

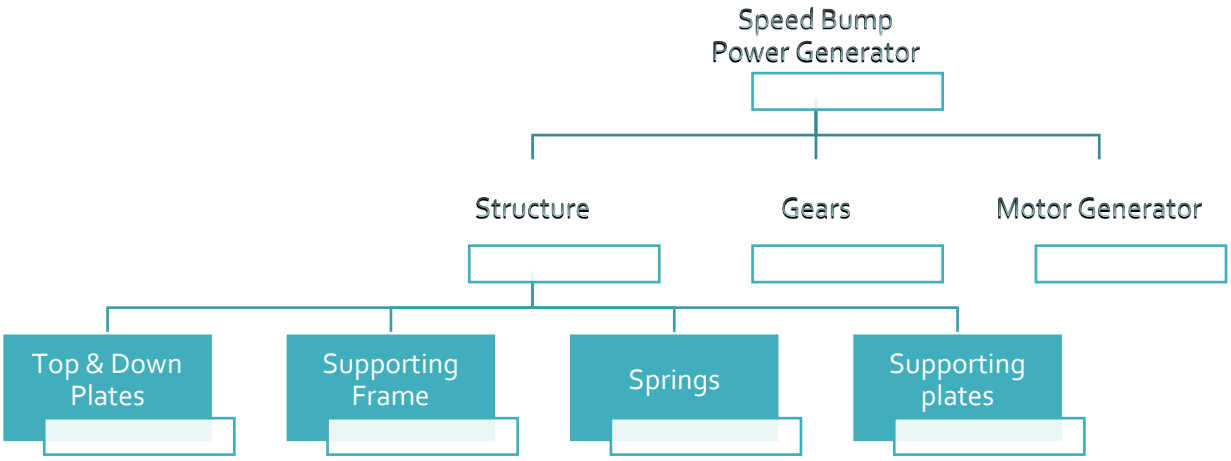
A. METHODS:

L-shapes window is inclined in certain small angle which is used to generate the power. The pushing power is converted into electrical energy by proper driving arrangement. The rack & pinion, spring arrangement is fixed at the speed breaker which is mounded bellow the L-shapes window. The spring is used to return the inclined L-shapes window in same position by releasing the load. The pinion shaft is connected to the supporter by end bearings. The larger sprocket also coupled with the pinion shaft, so that sprocket is running the same speed of pinion. The larger sprocket is coupled to the small cycle sprocket with the help of chain (cycle). This larger sprocket is used to transfer the rotation force to the smaller sprocket. The smaller sprocket is running same direction for the forward and reverse direction of rotational movement of the larger sprocket. This action looks like a cycle pedaling action. The fly wheel and gear wheel are also coupled to the smaller sprocket shaft. The flywheel is used to increase the rpm of the smaller sprocket shaft. The gear wheel is coupled to the generator shaft with the help of another gear wheel. The generator is used here, is permanent magnet D.C generator. The generated voltage is 12Volt D.C. This D.C voltage is stored to the Lead-acid 12 Volt battery. The battery is connected to the inverter. This inverter is used to convert the 12 Volt D.C to the 230 Volt A.C. This 230 Volt A.C voltage is used to activate the light, fan and etc. By increasing the capacity of battery and inverter circuit, the power rating is increased. This arrangement is fitted in speed bumps; the complete arrangement is kept inside the floor level except the pushing arrangement. There were methods used for manufacturing the parts. Every part

almost has been to the processes of cutting, drilling, and bending. The final shape of the Speed Bump Power Generator will look like as a cube.

B. CONSTRUCTION:

The speed bump power generator is made up of mild steel. The complete set up is fixed in this model speed bump. The two L-shapes frames are fixed in the above two ends of the track. Bellow the L-shapes window, the actual power generation arrangement is constructed. This L-shapes window pushes the rack when the time of train wheel moving on these arrangements. Basically, the machine to be constructed is an electromagnetic energy machine when the machine uses the magnetic field in generation of alternating current. The purpose of this device is basically a new concept that involves generation of non-conventional energy. The purpose of the machine is to convert the reciprocation motion to rotary motion. The machine is put under the speed breaker while installing various units. Secondly, the head of the rack is then brought up on the level that is just beneath the surface of the speed breaker. During the movement of the track on the speed breaker, the rack is usually pushed downwards. To facilitate working of the machine, the rack is attached to a free wheel type pinion which rotates in only one direction. The pinion and the rack are arranged in such a way that the arrangement will convert the reciprocation motion to rotary motion. A generator and a motor are basically important. The important thing is the amount of power that the machine produces at a unit time. During the production of electricity, there is something that makes the shaft and the armature to rotate. The power generator usually produces an alternating current. In order to convert the power to dc, the power which is generated is passed through a four-bridge rectifier which rectify the ac current to direct current and discharges the smooth capacitor and the and flow to the output. One of the manufacturing issues is the misalignment of the holes in the process of drilling and the misalignment in the welding process. The solution is to use a machine that has X and Y coordinates and perfectly locate the holes before drilling. In addition, to avoid the misalignment in welding process, the team should use the X and Y coordinates machine to mark the places that are going to welded. The top plate has a curved cap that needs to be angled. The rod supports will help the shafts to return to the position after every stroke. The L-brackets are designed to be angled 90 degrees to hold the device together. In addition, the manufacturing of the cap is a challenge because of the curve that the cap of the top plate has. The method that was used is to find a material that has already bent and bend this material into a way that is going to give cars the smooth to pass the speed bump. The cap manufacturing process has slowed the team members but return back on track as described below on the schedule section.



Estimated Project Cost:

The estimated project price is 500$. The estimated project price is considering structural, gears, and motor generator. However, the estimated price for structural parts is described below in the table.

Parts	**Cost**
Springs	30$
Supporting Plates	30$
Supporting Frame	50$
Top Plate	20$
Down Plate	20$
Rod Support	30$

Sultan Alanazi will do the gears, and Ibrahim Almarri will do the motor generator.

4. TESTING METHOD:

A. INTRODUCTION:

The Speed Bump Power Generator project consists of three different aspects that are essential. The three aspects of the project are Structural, Gears, and Motor Generator. The Structural part is focusing on the dimensions of the top and down plate, springs, L-shapes, and the outside structure. Gears part is focusing on how to convert the motional work into power or electricity. Motor Generator part is focusing on how to generate the converted power and transfer the power toward the targeted places such as streetlamps and signs. All of the three aspects need to be tested to predict the efficiency.

B. METHOD/APPROACH:

a. The project can be tested by using several methods. The method that is planned to be used to test the Speed Bump power generator is to apply a load on the top plate and springs to find out how much the project can endure. Also, the test is going to include how much electricity can be generated from the motion energy.
b. The testing procedures for this project is the multimeter. Multimeter will show how much of electricity is generated.
c. The Project will consist of three aspects in the testing method. First, the endurance of the project will be tested, which means that the project has to endure a load of 250 lb.
d. Second, the performance of the project will be tested, which means that the project has to meet the requirements such as to return to the original position or shape. In every stroke, the speed bump has to return to the original shape in no more than 3 seconds.
e. Finally, the generation of electricity will be tested. The device should generate no less than 8 Watts per stroke and must generate more power when there is more load. The generation of power can be checked by a multimeter or by applying a light bulb.
f. Appendix G is showing the data used in testing.
g. The speed bump power generator system consists of two major components that enable it to function efficiently. The two components are the mechanical and electrical components. One of the issues encountered during the construction of the system is the determination of the compatibility of the two components. The two components must be well compatible to work. It is because the two components are connected to each other through the rack and pinion.
h. To test the power generated by the speed bump power generator, a multimeter is connected to the direct current motor. A force is then applied, and the reading taken directly from the multimeter. Some of the issues encountered are the determination of the spring that will recoil at the minimum period. It is to ensure that the production efficiency is at maximum. Another issue is getting a spring that can withstand heavy forces. The spring should have a high elastic limit. During the measurement of the power produced by the generator, a force was needed to move the spring up and down. Another issue is getting the right power storage facility that can recharge at a minimum time. Lastly, the DC motor had broken. The gears inside the DC motor were misplaced and needed to be reattached together. The team members opened and fixed the misalignment of the gears inside the DC motor in order to generate power.

5. BUDGET:

a. The parts and costs are described in the table below.

PART IDENT	PART DESCRIPTION	SOURCE	COST APPROX. (USD)
Spring	OD.24mm Length 160, wire dia. 2mm	Amazon	21.00
Rack	L= 30 mm, B= 22 mm H= 180mm	Amazon	50.00
Pinion gear (3)	OD. = 58mm Bore = 12mm Width = 40mm	Amazon	48.00
DC motor	1000 RPM	Amazon	20.00
MS frame	Mild steel	Local steel supplier	35.00
shaft	Dia. 12mm x 206mm	Local steel supplier	13.00
Curve plate	Mild steel	Local steel supplier	12.00
Fasteners	M6, M5 bolts, nuts washers	Local hardware	17.00

		Cost total:	**216.00**

b. The labor for the Speed Bump Power Generator is going to be the team members of the project.

d. The estimated project cost is 216 USD. This cost is covering the parts buying only where there will be estimated additional costs to make the project efficient.
e. The budget for this project is divided into three sections. The first section is for buying the parts needed for this section, second section is for manufacturing the parts, and the third section is for rebuying the parts if the parts were bought or manufactured wrongly. 80% of the budget is for buying and manufacturing the parts, where 20% is solving the issues. Buying the parts costed the team members 173$. All parts were ordered, made and done correctly by the group members ahead of time before the deadline, and group members are ready for testing. None of the parts were left to obtain or predict, and so that will not affect the completion of the project.
f. The design of the project was not changed from the original design, so that the budget was not modified. In addition, all parts were bought and manufactured based on the timeline that group members planned.

f. The funding source for this project is the team members money. The team members are going to provide the money and buy all the parts that are needed for the project.
g. Team members bought and manufactured the parts correctly. However, some of the parts got broken due to high pressure. For example, the shaft got broken during the testing due to the high weight that was applied. The estimated budget percentage to repurchase a new shaft was 6.2%. The other issue that faced the group members is the broken motor. The motor got broken due the high rotation and was fully destroyed. The group members bought a new motor that consumed 4 % of the budget. However, when the new motor was bought, the motor got broken but not fully destroyed. The gears inside the motor were misplaced due to the high weight. Group members opened the motor and realigned the gears to get the motor working again.

6. SCHEDULE:

a. Gantt Chart is on Appendix E
b. As described above on the chart, there are estimated hours to finish the requirements of the projects such as a proposal, purchase of parts, machining the parts, documentation, etc. For example, the due date of the proposal is at the 6th of December and, the requirements of the proposal are as described on the table of contents.
c. The Speed Bump Power Generator project is divided into three quarters of work. The first quart (Fall) is to work on proposal, and the due date is at the 6th of December. The second quarter (Winter) is to start working and building the project at the 17th of January. The estimated total work duration is 169 hours.

d. The deliverable of the proposal section is the completed proposal and is due at the 6th of December. The deliverable of the analyses section is 12 green sheets with complete analyses. At the Winter quarter, manufacturing process is going to have a due date and the estimated duration of the Speed Bump Power Generator project is two months.

e. The schedule has been met until the group members started bending the cap of the top plate. Group members at first cut a metal and started bending with using basic methods such as placing a heavy metal over the metal that needed to be bent. However, that method was not functional because the metal was not shaped the way that the group members wanted. The group members tried another method by placing the metal at the end of a table and started to bend by hitting the metal with a hammer, but this method also was a disaster. Finally, the group members decided to use a piece of metal that was already bent, this metal was provided by Faisal Albalawy and bend that metal in the way that is going to give the cars the smooth to pass the speed bump. This issue had a slight impact on the schedule, but group members solved the issue in short time to get back on track.

f. Another issue that has played a role in delaying the completion of the project was the misalignment of the holes. The project was designed to have holes attached together in order to balance the speed bump and have every part in the right position and shape. The method that was used to solve this issue was using X and Y coordinates to mark the place that needed to be drilled. This issue increased the working hours to the double because the process was started over after the failing at the first time. Group members took advantage of the Winter break and started working on the project before Dr. Choi, Dr. Johnson, and professor Pringle assigned the manufacturing work in the Winter term. Most of the mistakes did not affect the project because the team members worked early to avoid mistake that might affect the completion of the project. As an engineer, every aspect was taking into consideration and project is completed at the scheduled time.

7. PROJECT MANAGEMENT:

a. The human resources for this project are the team members and the professors. Osamah and Mohammed will work on the structure of the project, Sultan and Faisel will work on the gears, and Ibrahim will work on the motor and electricity. Professors Pringle, Johnson, and Choi are going to be the directors and the consultants.
b. The project is most likely going to be processed and machined in the machining lab.
c. Solid Works is the app that this team used to help designing the project.
d. This team is going to fund the project. There are no sponsors for this Project.

8. DISCUSSION:

a. In the initial phase of the project an appropriate hydraulic system will be selected. The hydraulic system will definitely be fulfilling the requirements of the project. Then assembly process will be started. In this process the generator and the upper plate connections will be made in the most appropriate way. Wire connections will be made with the battery for collecting the electrical power in it. The bottom plate of the project will be connected at the final stages. After that the working of the device will be checked by applying the pressure on this.

b. Some of the risks which are associated with this project are flying chips or debris hazard. This can occur while cutting the metals. Also, the risk of receiving injury is also present while drilling the holes. The highest risk in this project will be present during the cutting process. Working without having any proper training can be quite dangerous for the team members.
c. The project will be considered as the successful one if this start to produce the voltages across its terminals of the generator as the pressure is applied over the hydraulic system. This is how the success will be measured.
d. The project business case document will be prepared in which this will be justified that why this project is important. A project charter will be made in which the whole project timeline, the requirements and budget related details will be present. RACI Matrix and WBS (Work break down structure) will be made. Risk issues Log and lesson learned documents will be added.

h. Next phase of the project will be assembling of the project. In that phase the initial working of the project will be checked.
i. The choose of springs is essential to assist the shafts and the top plates to return to the actual position in every stroke. The rack is going to be attached to the top plate; therefore, the top plate was manufactured, cut, and drilled according to the rack. In addition, the base plate is manufactured and ready for building and testing. The rod supports are holding the device together where shafts are built to be going through the rod supports. The rod supports were made and drilled according to the shafts in order to give allowance and flexibility to the shafts in every stroke.
j. Drilling was tricky and a problem because every part has a different size of hole, and every hole will be aligned with the other. This issue was solved by cation and group members precision.
k. Designing a device and manufacturing the device are different. The group members found issues when taking building the device into considerations. Group members have made every part correctly, but the issue is building. Therefore, the parts were numbered to know which part is linked with the other.
l. The device is designed to attach the parts together. One of the issues is the misalignment of the holes in the outside structure parts. The outside structure parts are designed to have two holes in each part to have a better stability. The issue is that group members were not able to attach the two holes at the same time. If the group members try to attach a hole on a part of the outside structure, the other hole will not be attached due to misalignment of the holes. To better solve the issue and have the device balanced and stabled and to not redo all the outside structure parts, group members have decided to create 90-degree parts on the down plate to hold onto the outside structure and do not allow the outside structure to misplace. The 90-degree parts are welded on the down plate and the outside structure parts are welded with the 90-degree parts.
m. The aspects that were focused on during testing were the endurance and the generation of power. The project should endure 500lb of load and produce no less than 10 Watts of power. Also, the structure of the project was not modified. The project is exactly as designed in Senior Project 1. Besides, the project has succeeded during the testing. The device has endured a load of 500lb and generated 15-19 Watts. However, one of the issues that group members have faced during the testing is that the motor has broken. The gears were misaligned inside the motor due to high pressure on placing the load over the Speed Bump. Group members opened the motor and realigned the gears in order to regenerate power.
n. The idea of the project is to create a speed bump that can endure cars and produce electricity from the motion that is provided by cars. The design was reviewed by group members over and over again. When the design was approved by group members, no modifications were made. In addition, there were issues that faced the group members during testing. One of the issues was the broken motor. The other issue is the movement of the device. The device should function and return to the original position in no more than

3 seconds. However, the shafts that are attached to the springs get stuck when going down in every stroke. So, group members oiled the shaft to solve the issue. The device then functions and return to the original position in no more than 3 seconds.

Generally, the amount of output that is generated is sufficient in lighting up low power gadgets such as the streetlights, the road sign, and the power can be used in changing of phones and also performing several functions that require minimal power.

9. CONCLUSION:

The design title of this project is "Speed Bump Power Generator". This design will be able to produce the electric power by converting energy from the motion of the vehicles which will be passing over the speed bumps. The whole project will be ready to install in any speed bump to produce the electrical energy. The most important part of the project will be the right choice of the springs. That will be the springs which have the capability to use the force for producing the right amount of displacement. This designing process will be done with the use of Hooke's law According to this law. F=kx

The other important equations which will be helpful in order to design this project correctly will be

$$Stress=FA$$

Here F is the force, k is the spring constant, x is the displacement and A is the area of the upper plate of the project. Use of correct dimensions will also be important for the success of the project. The predicted vs. actual performance of the project will be as described below:

a. The speed bump will generate electricity provided by cars' motion.

b. Springs will take 3 seconds to return to the original position.

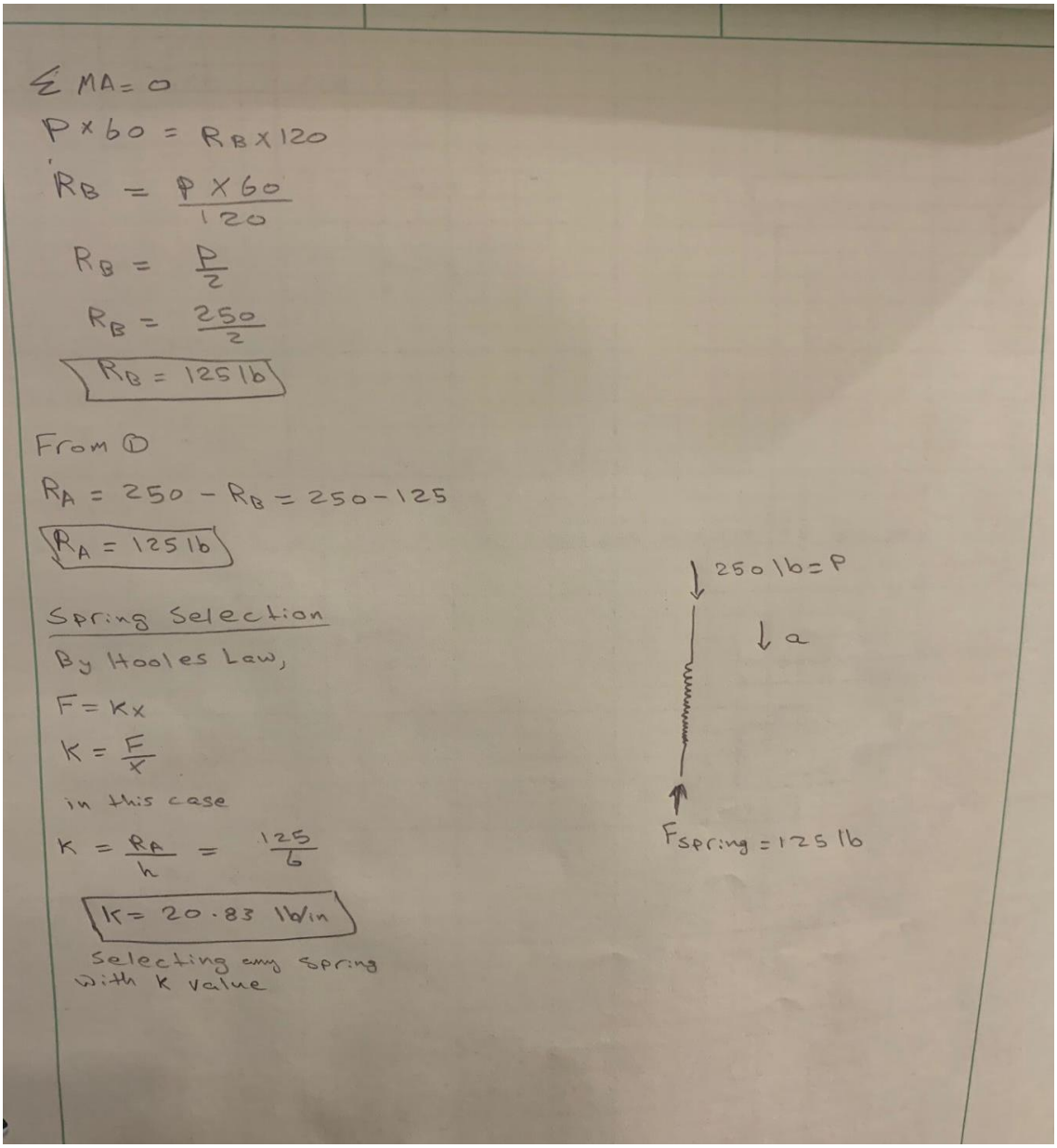
c. The speed bump will endure a load of 250 lb.

10. ACKNOLEDGMENT:

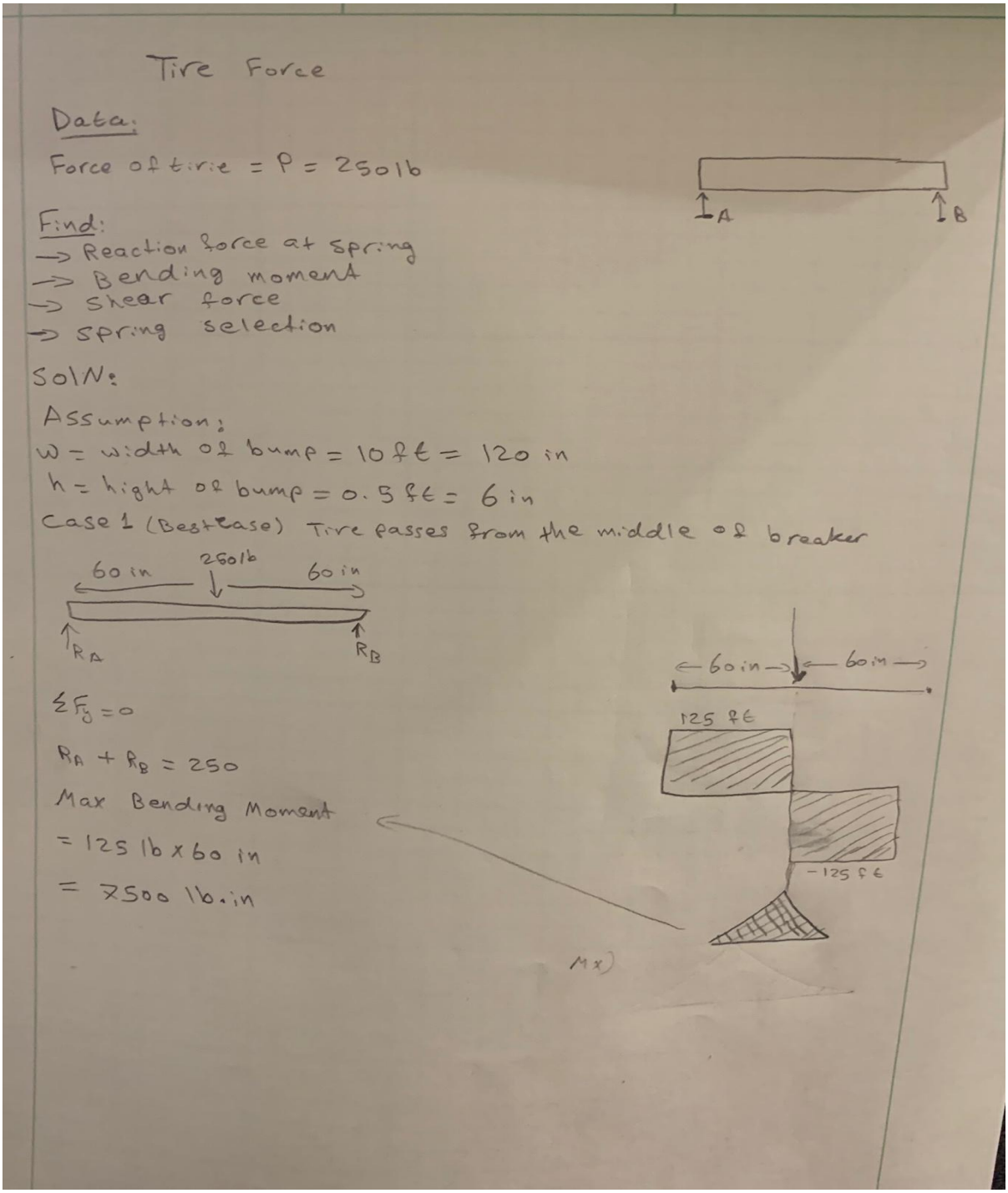
Group members funded the whole project and do not have any sponsor. Group members have worked on machining and manufacturing the parts in Faisal Albalawy's Shop. Faisal Albalawy is a friend who has experience in Mechanical Engineering and have a shop with all the equipment that were needed for machining the parts. Faisal Albalawy is the mentor for the Speed Bump Power Generator.

12. APPENDIX A ANALYSIS

APPENDIX A1 – SPRING SELECTION



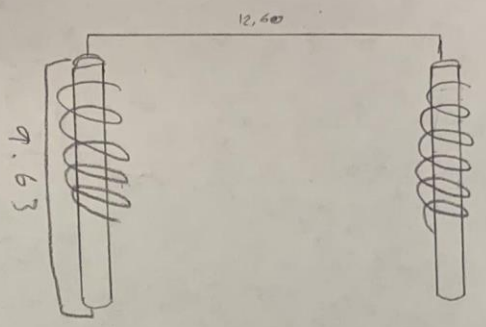
APPENDIX A2 – REACTION FORCES AT SPRINGS



APPENDIX A3 – PROJECT REQUIREMENTS 1

Osamah Abulghaith

① The spring will endure a load of 250 lb.



② The Length is 9.63 in

③ The distance between the two springs is 12.60 in

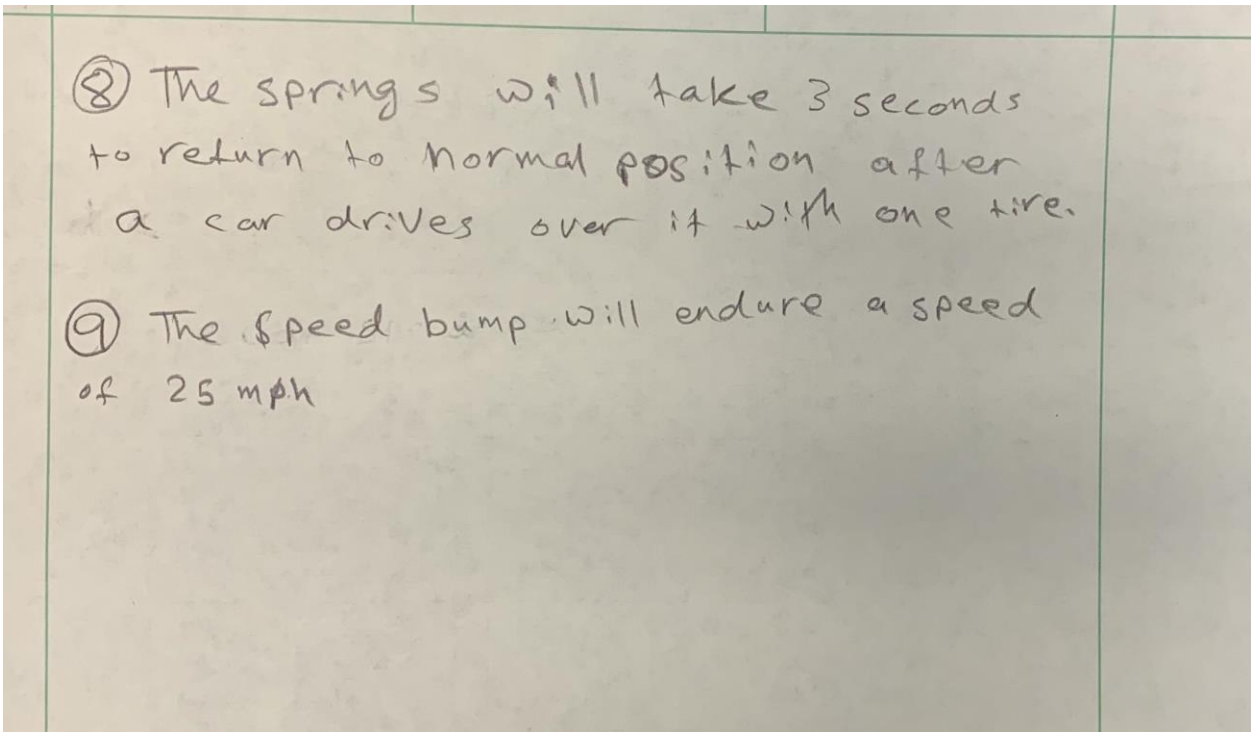
④ These dimensions are Solidworks dimensions

⑤ The Force of the spings is 125 lb

⑥ The K constant is 20.83 lb/in

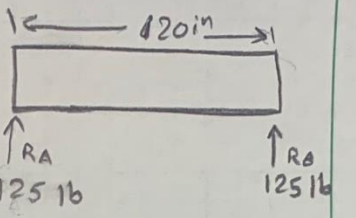
⑦ $R_A = 125$ lb and $R_B = 125$ lb

APPENDIX A4 – PROJECT REQUIREMENTS 2



APPENDIX A5 – PROJECT DIMENSIONS AND ASSUMPTIONS 1

① The length of th top plate is 120 in



② The best case scenario is that the tire will pass from the middle of the breaker with a load of 250 lb max.

③ The springs will be attatched at the two ends.

④ The hight of the bump is 6 in

⑤ The plates will be made up by steel.

⑥ There will be a steel-bar in the middle of the plate to support it.

APPENDIX A6 – PROJECT DIMENSIONS AND ASSUMPTIONS 2

(7) The bending moment is 7500 lb.in

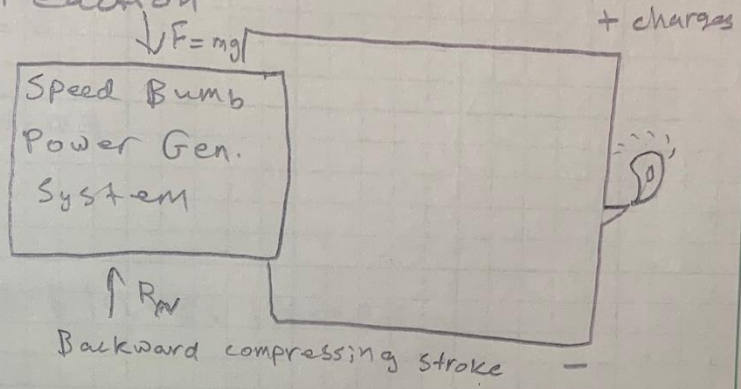
(8) The down plate will have the two springs attached at the two ends.

(9) The length of the down and top plate is the same.

(10) The down plate will give the Speed Bump power generator balance.

F = One tire weight (F = mg)

R_W = Normal reaction



Design Calculations of supporting plates

Length of supporting plate = L = 11.81 in

Width " " " = W = 3.94 in

Thickness " " " = t = 4.09 in

Area " " " = A = L x W

= 11.81 x 3.94 in^2

= 46.53 in^2

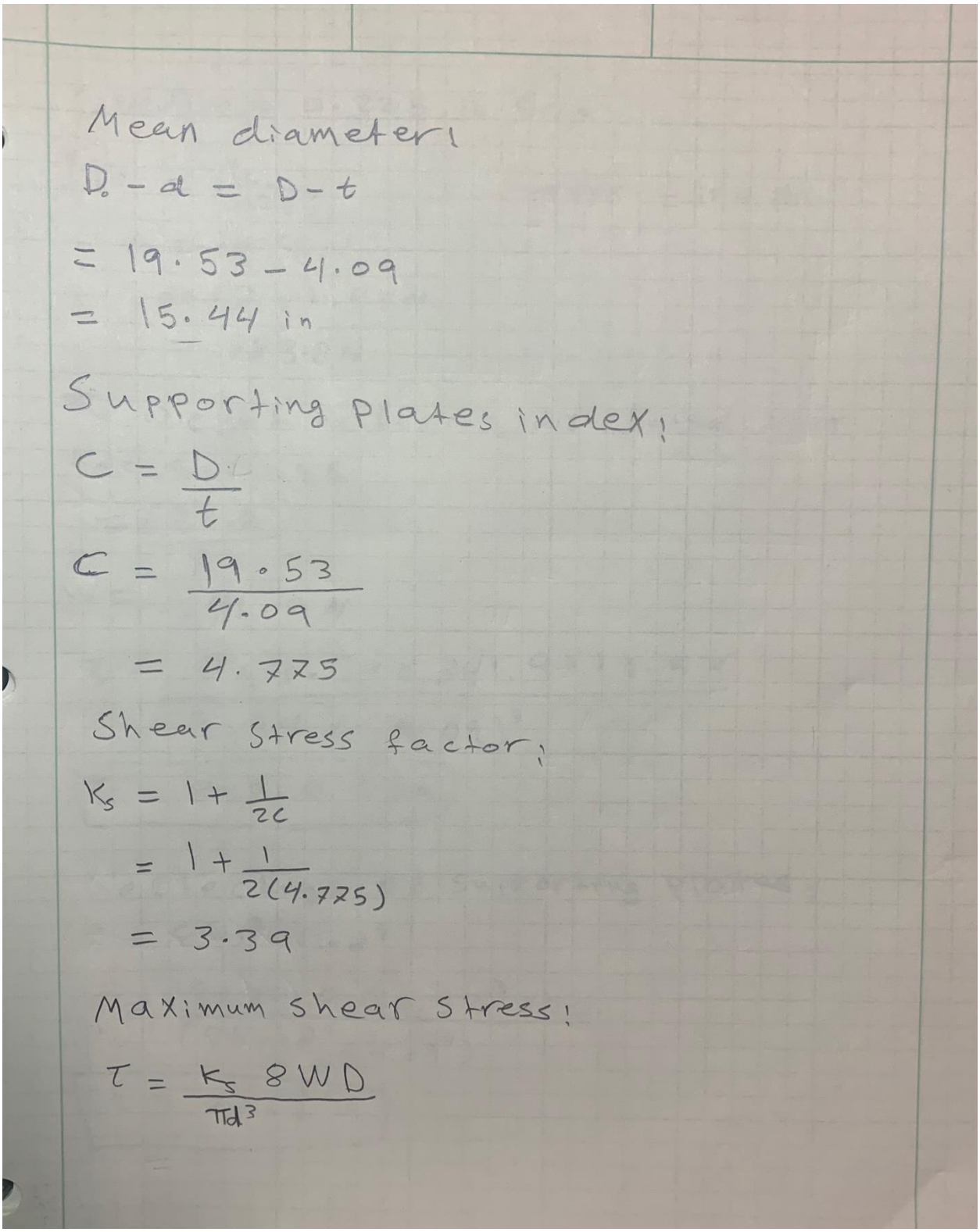
Volume of supporting plate

= L x W x t

= 11.81 x 3.94 x 4.09

= 190.3 in^2

APPENDIX A8 – DESIGN CALCULATIONS OF SUPPORTING PLATES 1



Mean diameter:

$D_o - d = D - t$

$= 19.53 - 4.09$

$= 15.44$ in

Supporting plates index:

$C = \frac{D}{t}$

$C = \frac{19.53}{4.09}$

$= 4.775$

Shear stress factor:

$K_s = 1 + \frac{1}{2C}$

$= 1 + \frac{1}{2(4.775)}$

$= 3.39$

Maximum shear stress:

$\tau = \frac{K_s \, 8WD}{\pi d^3}$

APPENDIX A9 – DESIGN CALCULATIONS OF SUPPORTING PLATES 2

1 Newton = 0.225 lb force

$1\ lb = \frac{1}{0.225}$ Mass = 154 lb

$= 4.44\ N$

$= 154 \times 4.44\ N$

$= 683.8\ N$

The weight uniformly distributed over two springs

$= \frac{683.8}{2}$

$W = 341.9\ N$

$$\tau = \frac{8 \times 3.39 \times 341.9 \times 19.53}{3.14 \times (4.09)^3}$$

$\tau = 842.9\ MPa$

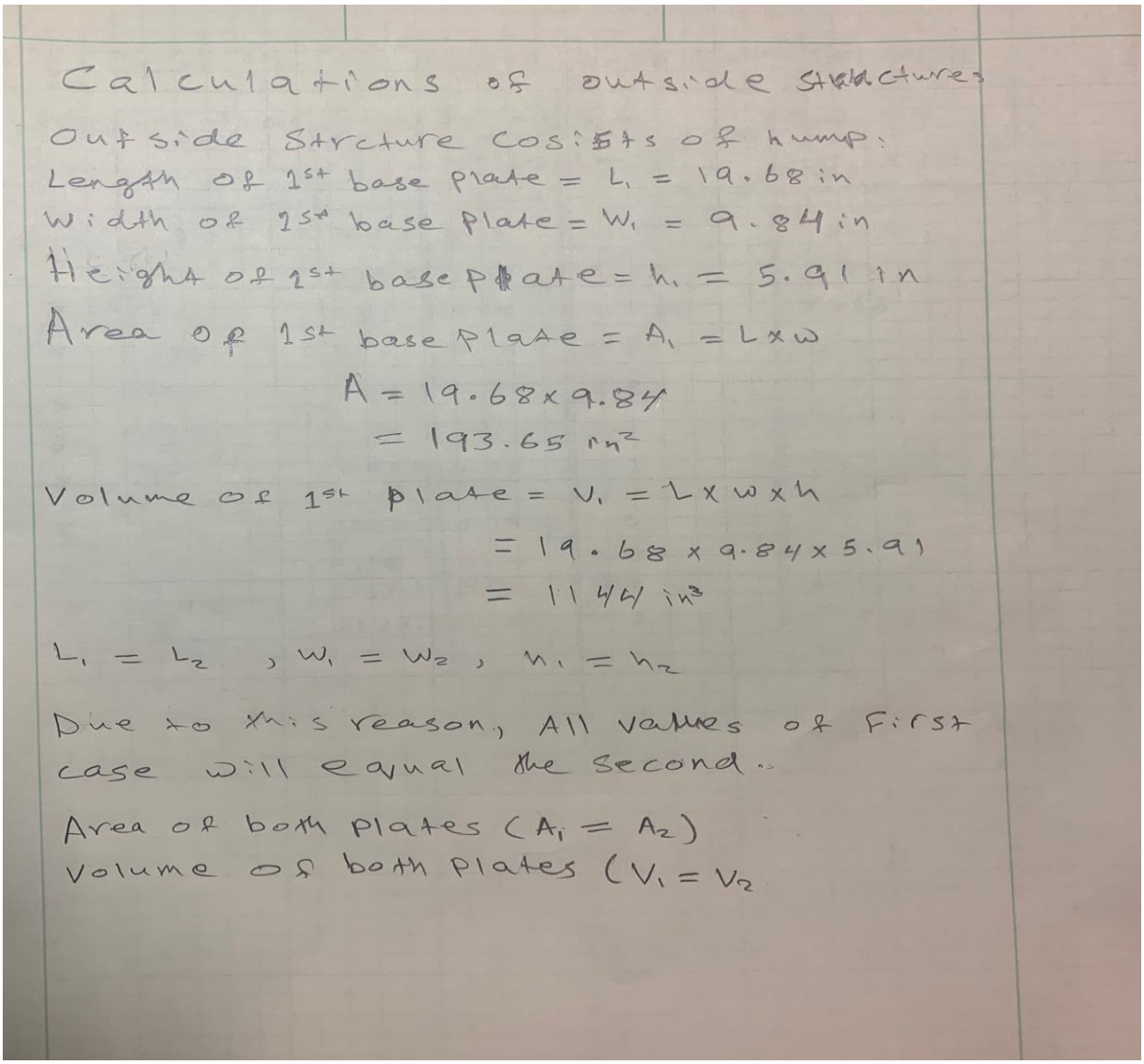
Deflection of supporting plates:

$\delta = 8WD^3n / Gd^4$

$$\delta = \frac{8 \times 341.9 \times (19.53)^3 \times 20}{(84 \times 10^3 \times 4.09^4)}$$

$\delta = 0.173\ in$

APPENDIX A10 – CALCULATIONS OF OUTSIDE STRUCTURE



Calculations of outside structures

Outside Strcture consists of hump:

Length of 1st base plate = L_1 = 19.68 in

Width of 1st base plate = W_1 = 9.84 in

Height of 1st base plate = h_1 = 5.91 in

Area of 1st base plate = $A_1 = L \times w$

$A = 19.68 \times 9.84$

$= 193.65\ in^2$

Volume of 1st plate = $V_1 = L \times w \times h$

$= 19.68 \times 9.84 \times 5.91$

$= 1144\ in^3$

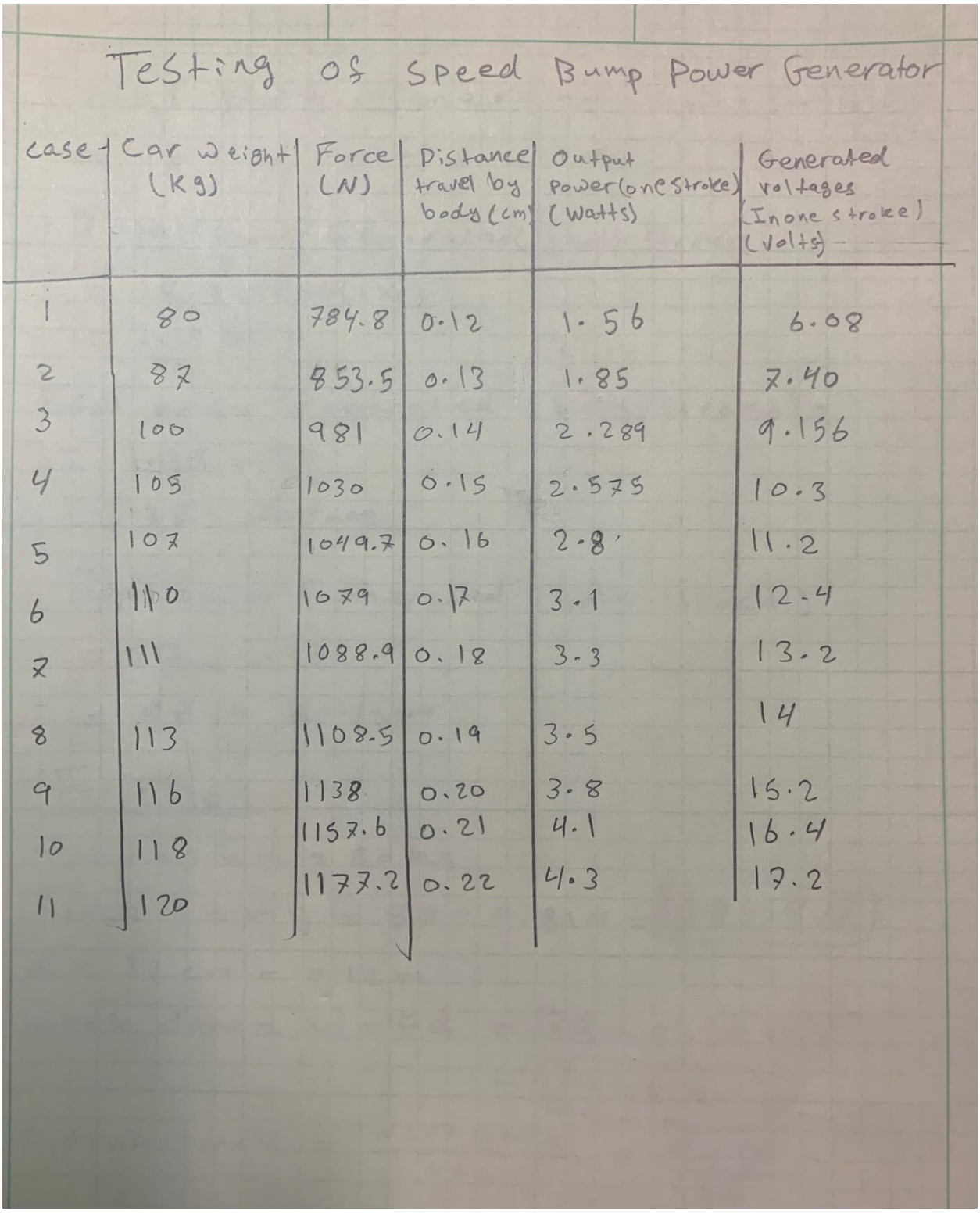
$L_1 = L_2$, $W_1 = W_2$, $h_1 = h_2$

Due to this reason, All values of First case will equal the second..

Area of both plates ($A_1 = A_2$)

Volume of both plates ($V_1 = V_2$

APPENDIX A11 – PROJECT TESTING



Testing of Speed Bump Power Generator

case	Car weight (Kg)	Force (N)	Distance travel by body (cm)	Output power (one stroke) (Watts)	Generated voltages (In one stroke) (Volts)
1	80	784.8	0.12	1.56	6.08
2	87	853.5	0.13	1.85	7.40
3	100	981	0.14	2.289	9.156
4	105	1030	0.15	2.575	10.3
5	107	1049.7	0.16	2.8	11.2
6	110	1079	0.17	3.1	12.4
7	111	1088.9	0.18	3.3	13.2
8	113	1108.5	0.19	3.5	14
9	116	1138	0.20	3.8	15.2
10	118	1157.6	0.21	4.1	16.4
11	120	1177.2	0.22	4.3	17.2

APPENDIX A12 – POWER GENERATING IN EVERY STROKE 1

Total power Generated (in both strokes)
= 18.84 W during 1 min

Total power Generated (both strokes)
= 18.84 x 60 (1 hr)
= 1.13 KWh

Total power Generated (both strokes) :
= 1.13 x 24
= 27.1 KW/day

Total power Generated (both strokes)
= 27.1 x 365
= 9899 KW/year

For case 1 :

Tire mass = m = 80 kg

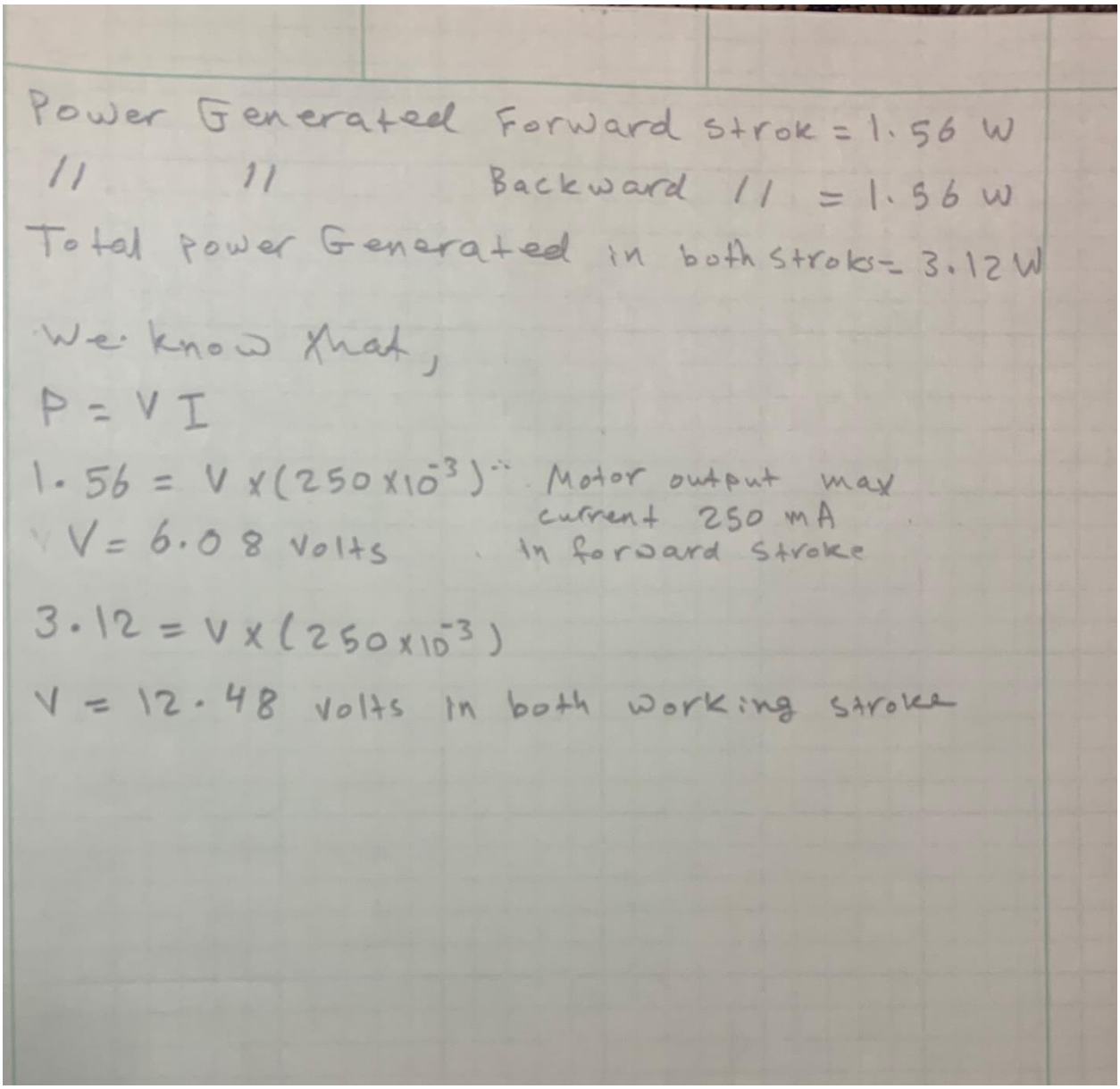
Force F = mg = 80 x 9.81 N = 784.8 N

d = 12 cm = 0.12 m

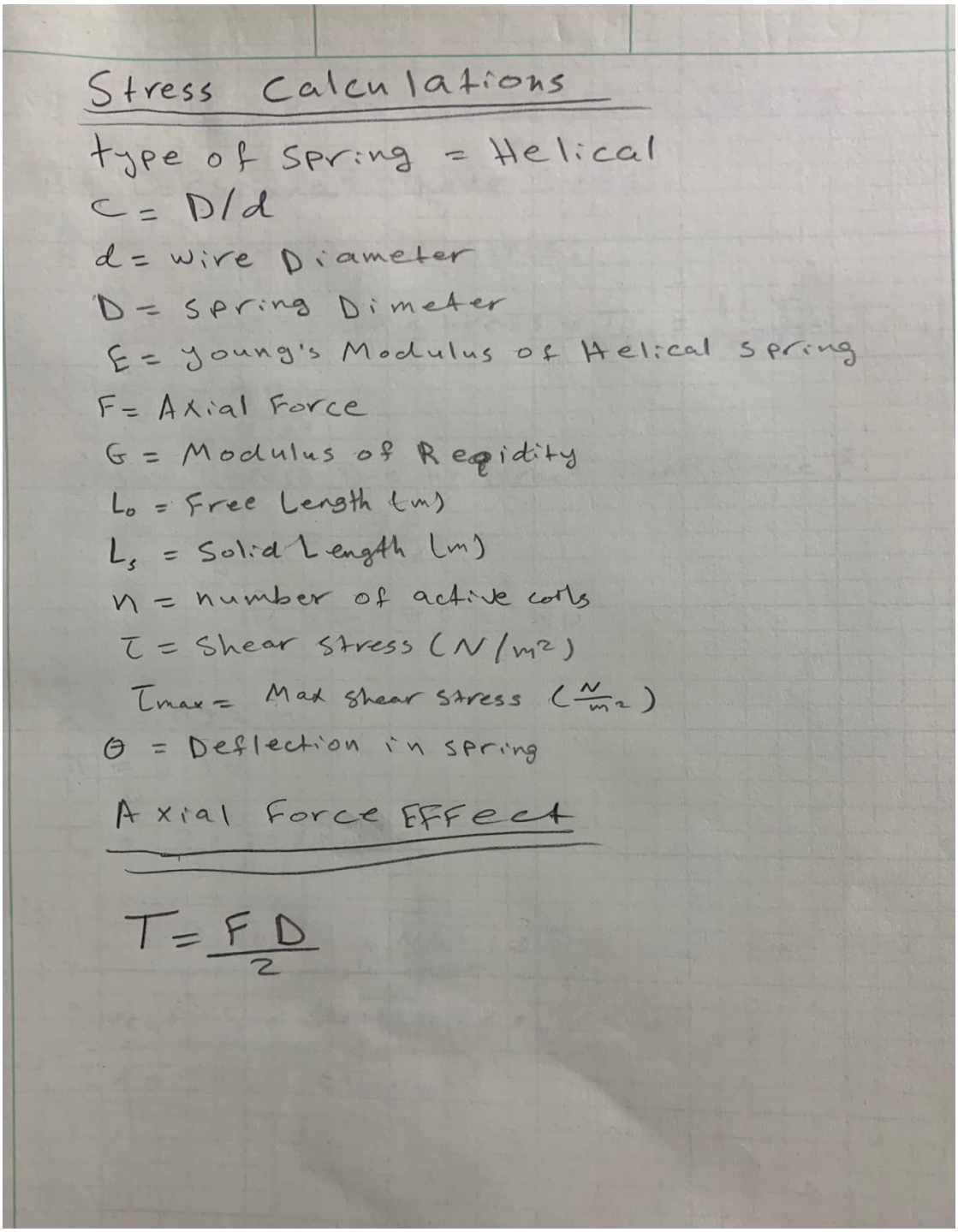
Work done = W = Fd = (784.8)(0.12)
= 94.17 Nm

Output power = $\frac{\text{Work done}}{\text{sec}} = \frac{94.17}{60}$
= 1.56 W
For one stroke

APPENDIX A13 – POWER GENERATING IN EVERY STROKE 2



APPENDIX A14 – STRESS CALCULATIONS



Stress Calculations

type of Spring = Helical

$C = D/d$

d = wire Diameter

D = spring Dimeter

E = young's Modulus of Helical spring

F = Axial Force

G = Modulus of Rigidity

L_o = Free Length (m)

L_s = Solid Length (m)

n = number of active coils

τ = Shear Stress (N/m^2)

τ_{max} = Max shear stress ($\frac{N}{m^2}$)

θ = Deflection in spring

Axial Force Effect

$$T = \frac{F D}{2}$$

APPENDIX A15 – TWO TYPES OF STRESSES IN SPRING

Two Types of stresses in Spring

1- Torsional shear Sress

2- Direct shear stress

Torsional shear stress = $\tau_t = \frac{16T}{\pi d^3}$

$\tau_t = \frac{8FD}{\pi d^3}$

Shear stress Due to Direct shear Force F

$\tau_d = \frac{F}{\frac{\pi d^4}{4}} = \frac{4F}{\pi d^3}$

Force on the bump = F = 80 N

D = 0.005 m

d = 0.032 m

$\pi = 3.14$

$\tau_t = \frac{8 \times 80 \times 0.005}{3.14 \times 0.032^3}$

$\tau_t = 31100.216\ N/m^2$ ⇒ Torsional shear stress

Direct shear stress = $\tau_d = \frac{4 \times 80}{3.14 \times 0.032^2}$

$\tau_d = 99522.29\ N/m^2$

APPENDIX A16 – RESULTANT SHEAR STRESS

Resultant Shear stress

$\tau = \tau_t + \tau_d$

$\tau = K_s \left(\frac{8FC}{\pi d^2}\right)$

$\tau = 31100.716 + 99522.29$

$\tau = 130623.009\ N/m^2$

$\tau_{spring-1} = \frac{130623.009}{2} = 65311\ \frac{N}{m^2}$

σ = Stress experienced by base plate

$\sigma = \frac{F}{L \times w}$

$L = 11.81$ in

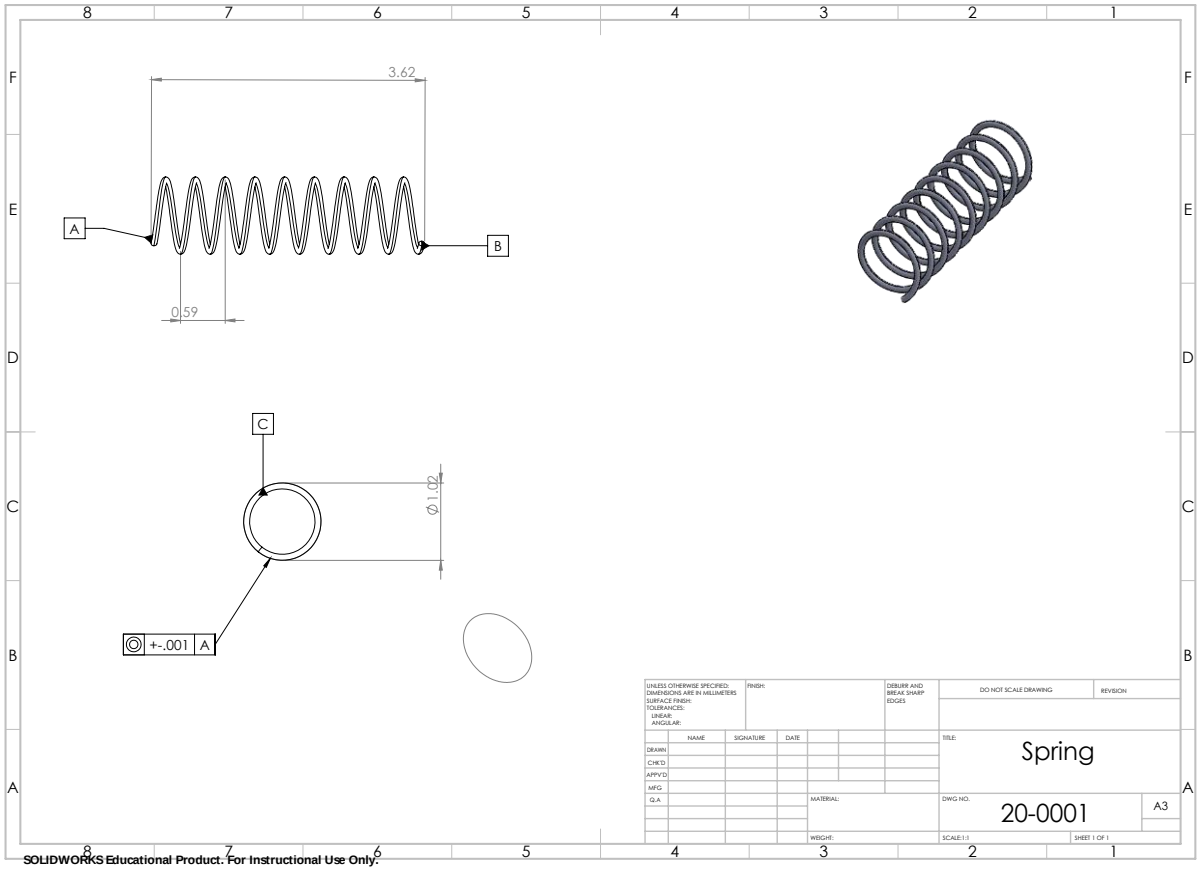
$W = 3.94$ in

$\sigma = \frac{80}{\left(\frac{11.81}{12 \times 3.28}\right)\left(\frac{3.94}{12 \times 3.28}\right)}$

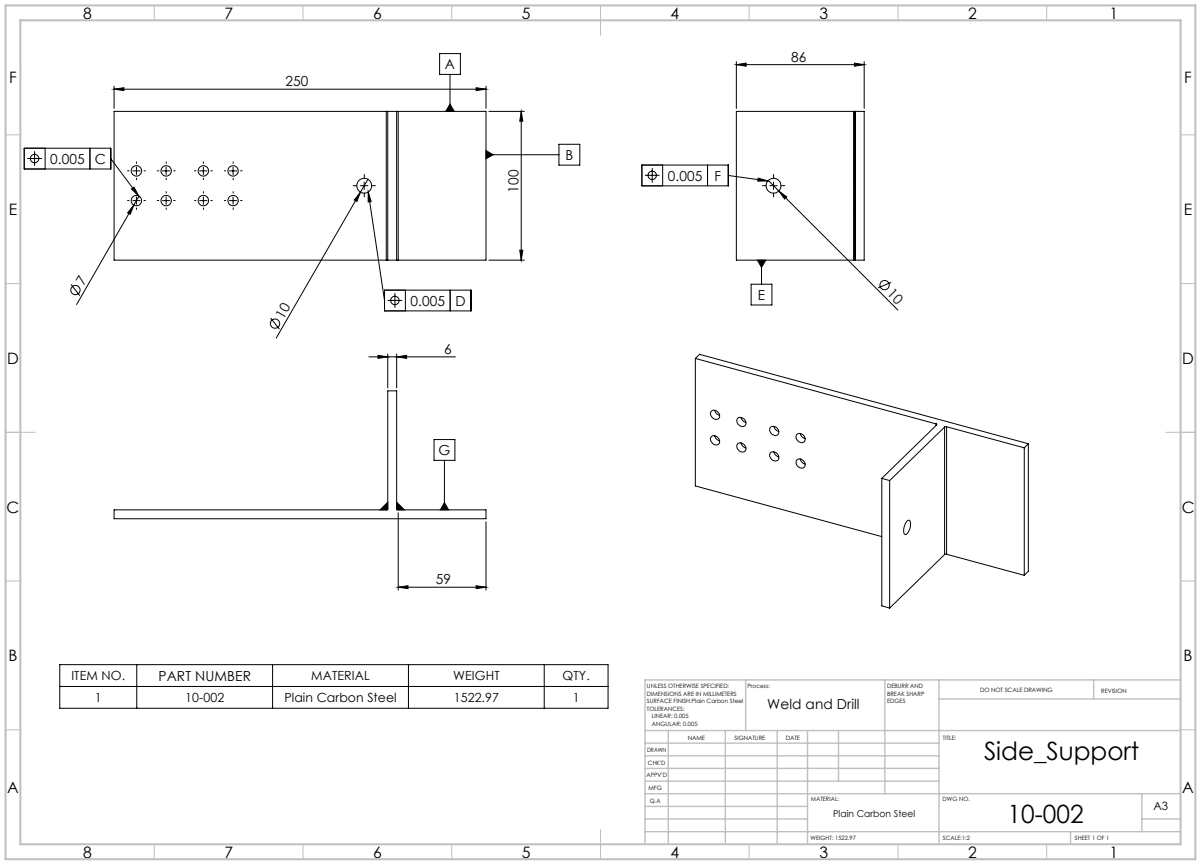
$\sigma = 2663.5\ \frac{N}{m^2}$

13. APPENDIX B_ DRAWING

B1: SPRING



B2: SIDE SUPPORT



ITEM NO.	PART NUMBER	MATERIAL	WEIGHT	QTY.
1	10-002	Plain Carbon Steel	1522.97	1

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILLIMETERS
SURFACE FINISH:Plain Carbon Steel
TOLERANCES:
LINEAR: 0.005
ANGULAR: 0.005

Process: Weld and Drill

DEBURR AND BREAK SHARP EDGES

DO NOT SCALE DRAWING | REVISION

	NAME	SIGNATURE	DATE
DRAWN			
CHK'D			
APPV'D			
MFG			
Q.A.			

TITLE: Side_Support

MATERIAL: Plain Carbon Steel

DWG NO. 10-002

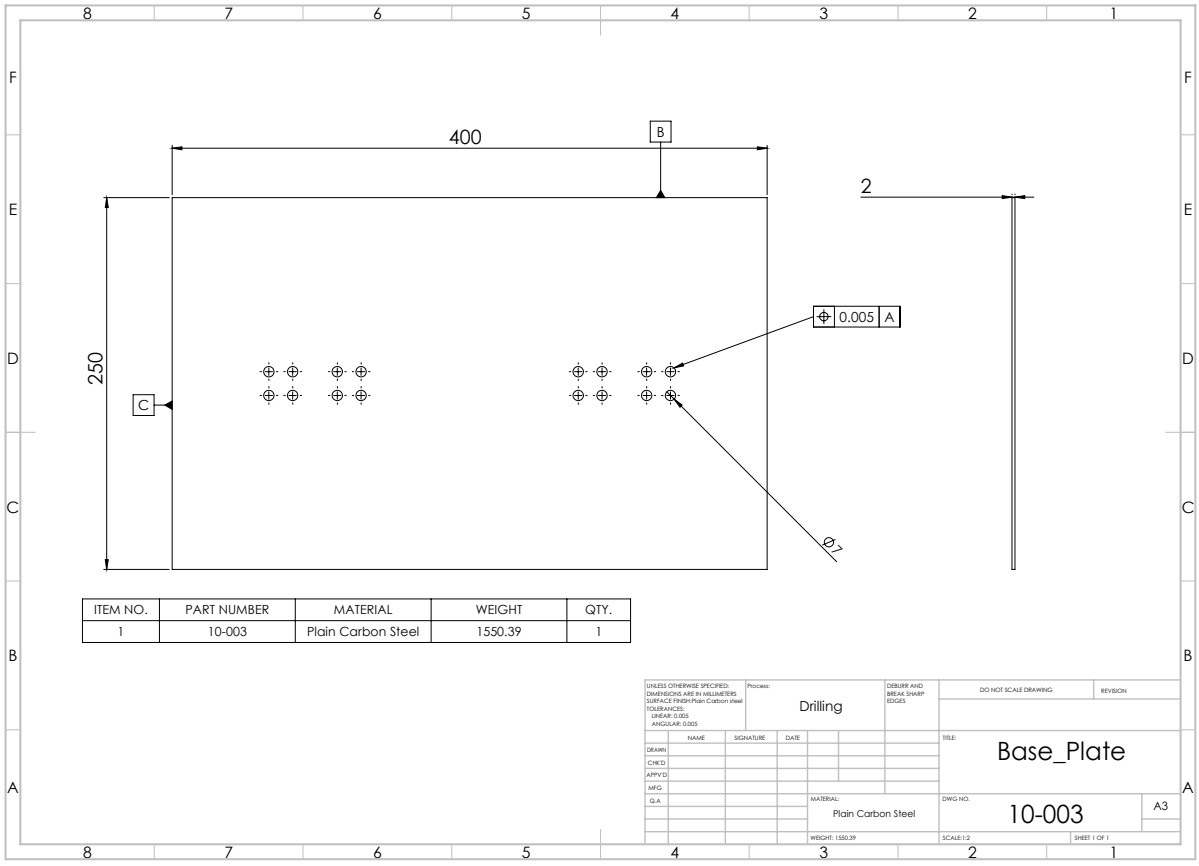
A3

WEIGHT: 1522.97

SCALE:1:2

SHEET 1 OF 1

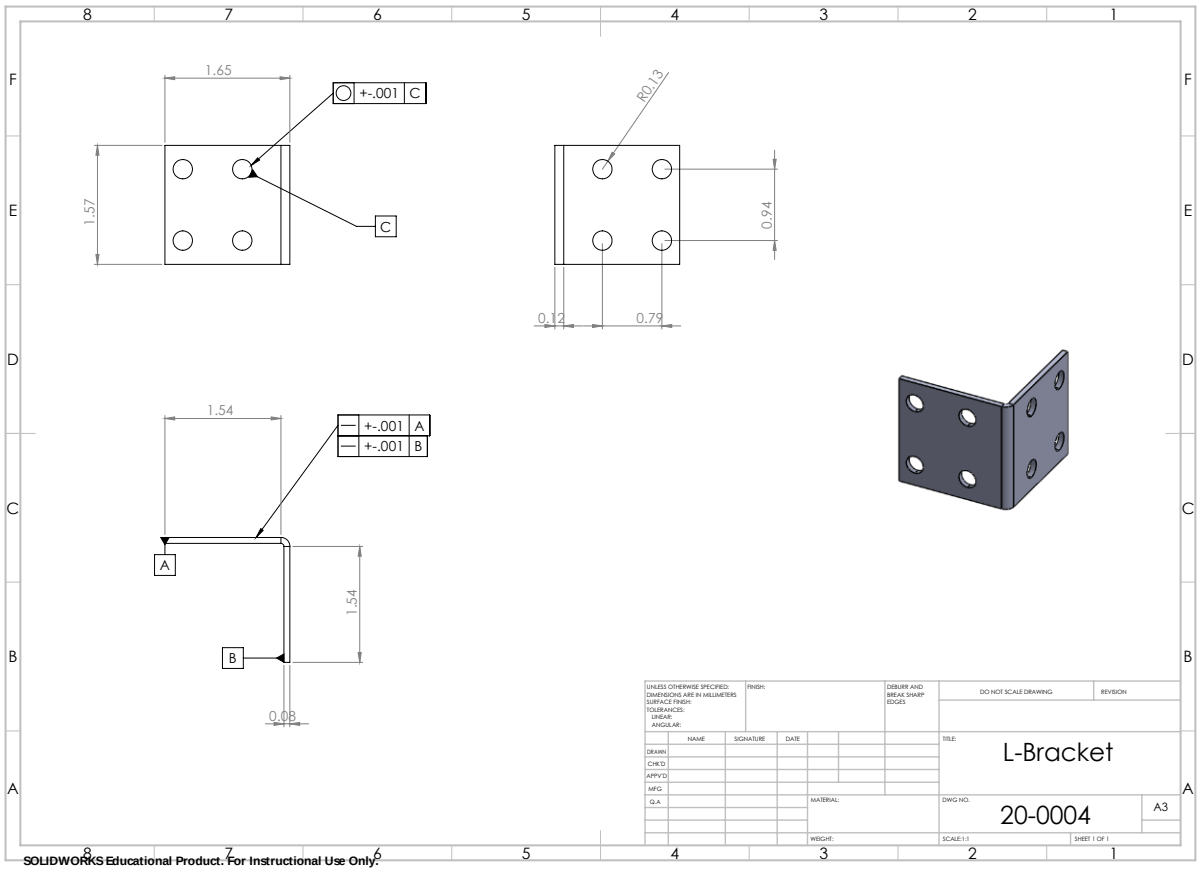
B3: BASE PLATE



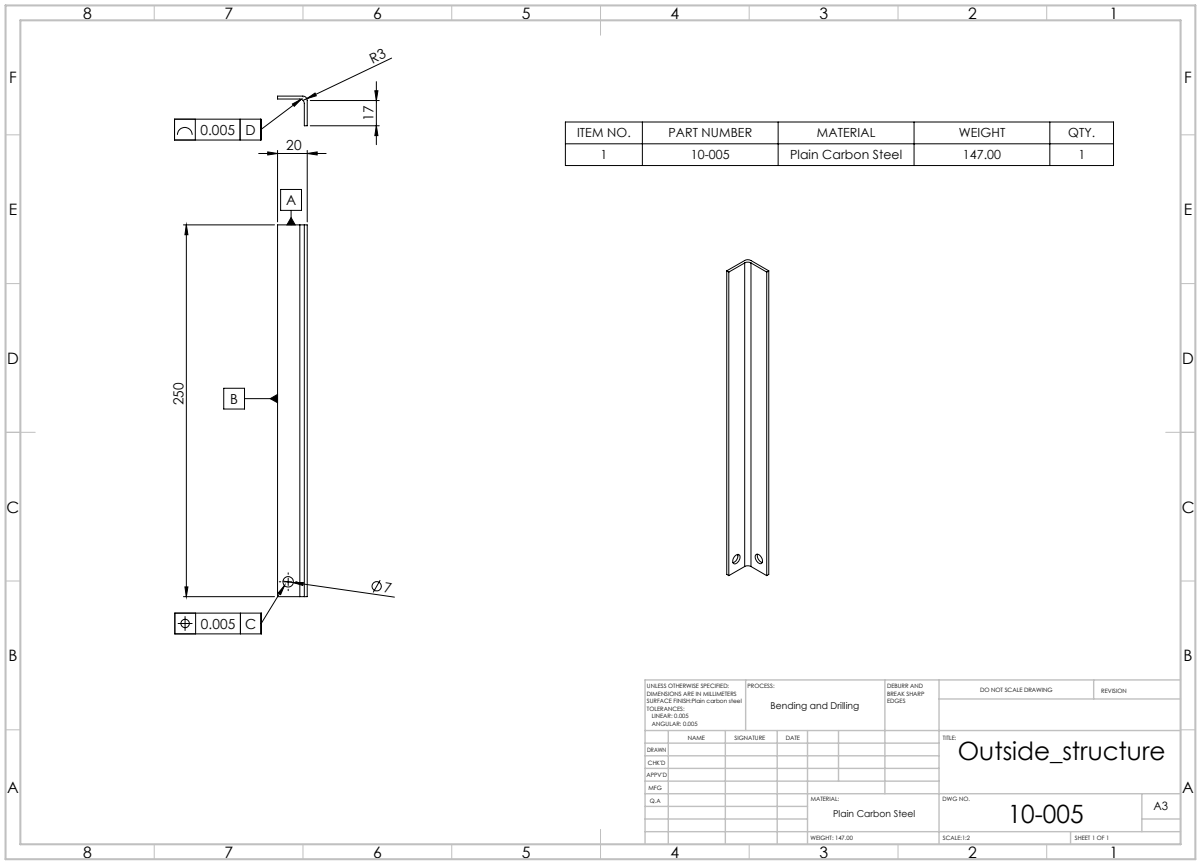
ITEM NO.	PART NUMBER	MATERIAL	WEIGHT	QTY.
1	10-003	Plain Carbon Steel	1550.39	1

UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS SURFACE FINISH:Plain Carbon steel TOLERANCES: LINEAR: 0.005 ANGULAR: 0.005	Process: Drilling		DEBURR AND BREAK SHARP EDGES	DO NOT SCALE DRAWING / REVISION
	NAME / SIGNATURE / DATE			TITLE: Base_Plate
DRAWN				
CHK'D				
APPV'D				
MFG				
Q.A.		MATERIAL: Plain Carbon Steel		DWG NO. 10-003 / A3
		WEIGHT: 1550.39		SCALE:1:2 / SHEET 1 OF 1

B4: L-BRACKET



B5: OUTSIDE STRUCTURE



ITEM NO.	PART NUMBER	MATERIAL	WEIGHT	QTY.
1	10-005	Plain Carbon Steel	147.00	1

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILLIMETERS
SURFACE FINISH:Plain carbon steel
TOLERANCES:
LINEAR: 0.005
ANGULAR: 0.005

PROCESS: Bending and Drilling

DEBURR AND BREAK SHARP EDGES

DO NOT SCALE DRAWING | REVISION

	NAME	SIGNATURE	DATE
DRAWN			
CHK'D			
APPV'D			
MFG			
Q.A.			

TITLE: Outside_structure

MATERIAL: Plain Carbon Steel

DWG NO. 10-005

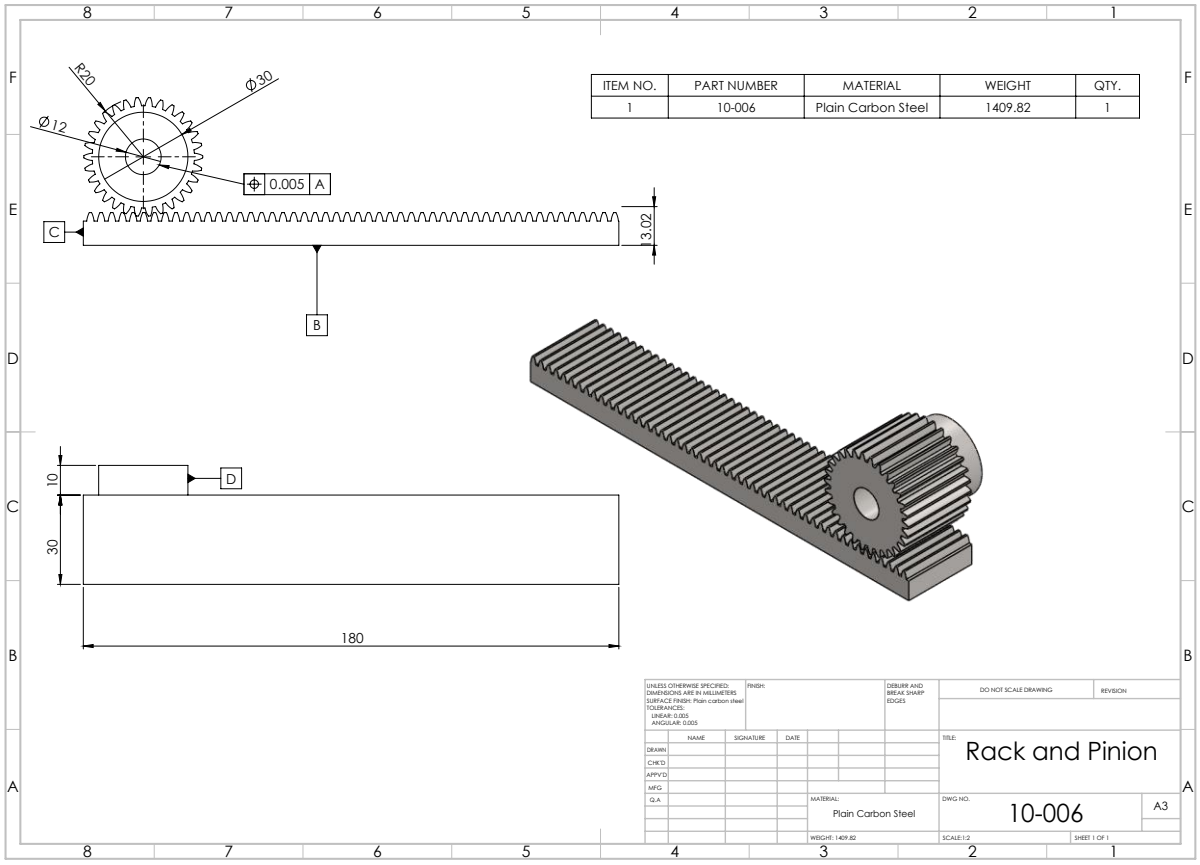
A3

WEIGHT: 147.00

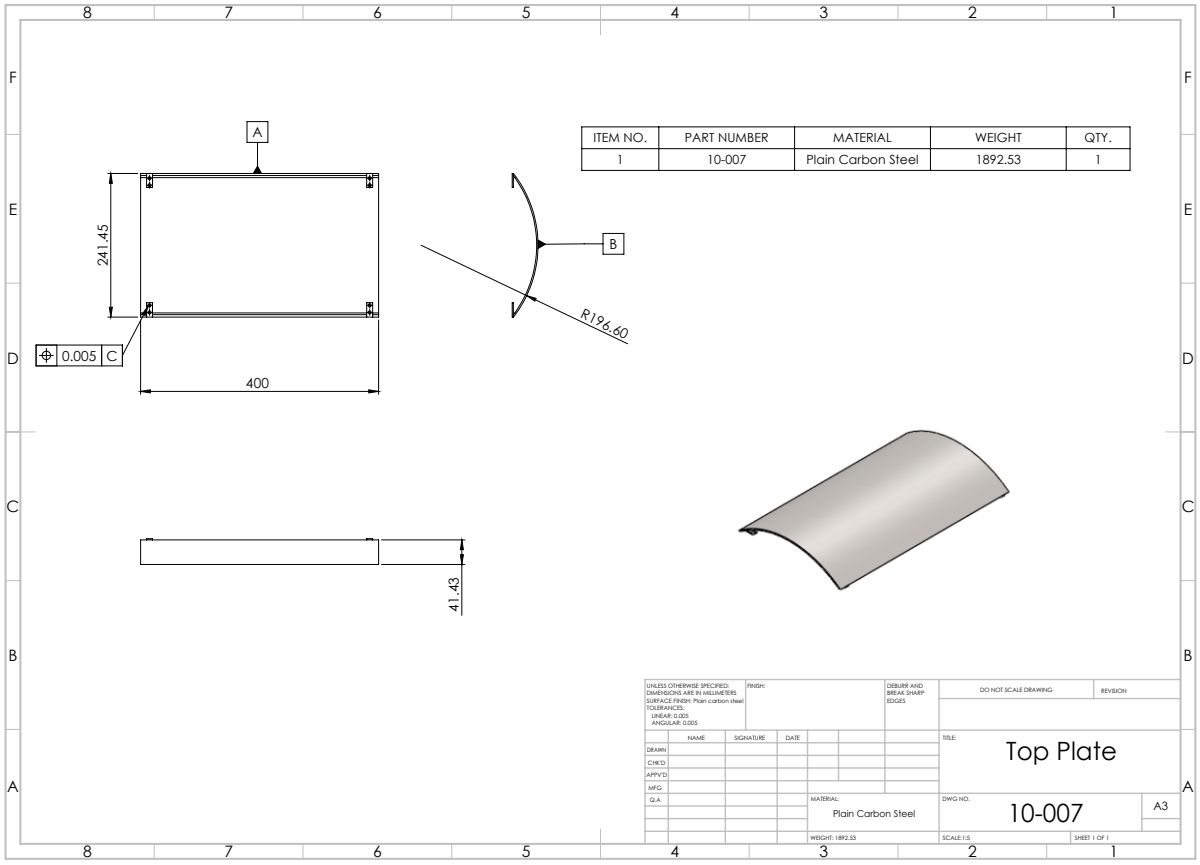
SCALE:1:2

SHEET 1 OF 1

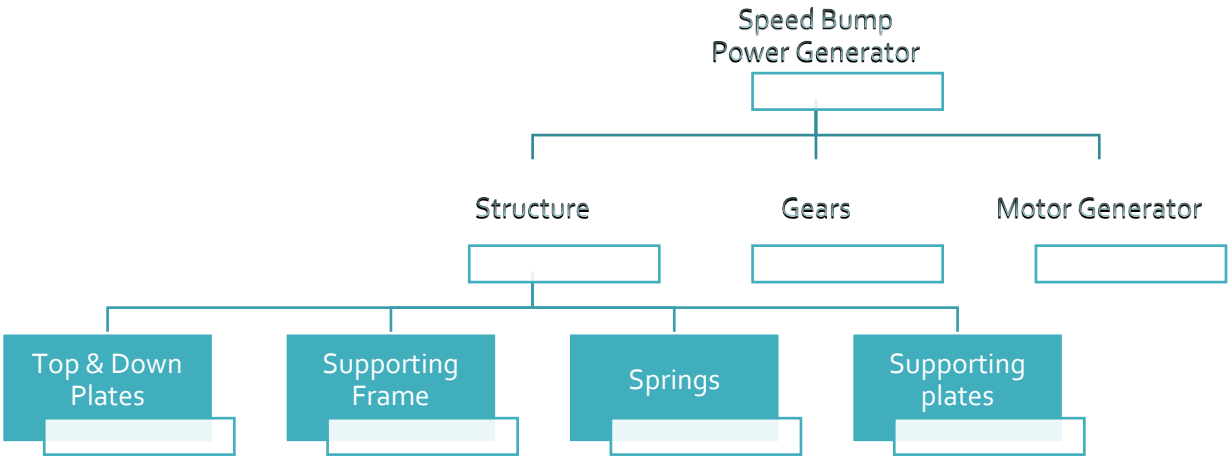
B6: RACK & PINION



B7: TOP PLATE



B8: DRAWING TREE



14. APPENDIX C_ PART LIST

PART IDENT	PART DESCRIPTION	SOURCE	COST APPROX. (USD)	DISPOSITION
Spring	OD.24mm Length 160, wire dia. 2mm	Amazon	21.00	
Rack	L= 30 mm, B= 22 mm H= 180mm	Amazon	50.00	
Pinion gear (3)	OD. = 58mm Bore = 12mm Width = 40mm	Amazon	48.00	
DC motor	1000 RPM	Amazon	20.00	
MS frame	Mild steel	Local steel supplier	35.00	
shaft	Dia. 12mm x 206mm	Local steel supplier	13.00	
Curve plate	Mild steel	Local steel supplier	12.00	
Base Plate	Mild Steel	Local steel supplier	15	
Top Plate	Mild Steel	Local steel supplier	15	
Fasteners	M6, M5 bolts, nuts washers	Local hardware	17.00	
Side Support	Mild steel	Local Supplier	30	

Screws			15	
		Cost total:	**291.00**	

SENIOR PROJECT TITLE _**Speed Bump Power Generator**_

							Cost:		
ITEM ID	ITEM Description	Item Source	Brand Info	Model/SN	Price/Cost (US Dollars) ($ / hour)	Quantity (or hrs)	Subtotals	Actual $	
20-0001	Spring	Amazon.com	MD Steel	A569/ASTM A1011	21	1	21		
20-0002	Side Support	Amazon.com	MD Steel	A569/ASTM A1011	30	1	30		
20-0003	Base Plate	Amazon.com	MD Steel	A569/ASTM A1011	15	1	15		
20-0004	L-Bracket	Amazon.com	MD Steel	A569/ASTM A1011	30	1	30		
20-0005	Outside Structure	Amazon.com	MD Steel	A569/ASTM A1011	35	1	35		
20-0006	Rack & Pinion	Amazon.com	MD Steel	A569/ASTM A1011	98	1	98		
20-0007	Top Plate	Amazon.com	MD Steel	A569/ASTM A1011	15	1	15		
20-0008	Drawing Tree			Unknown		1	0		
						Tot Est.$	244	0	Tot Act. $

15. APPENDIX D_ BUDGET

PART IDENT	PART DESCRIPTION	COST Total (USD)
Spring	OD.24mm Length 160, wire dia. 2mm	21.00
Rack	L= 30 mm, B= 22 mm H= 180mm	50.00
Pinion gear (3)	OD. = 58mm Bore = 12mm Width = 40mm	48.00
DC motor	1000 RPM	20.00
MS frame	Mild steel	35.00
shaft	Dia. 12mm x 206mm	13.00
Curve plate	Mild steel	12.00
Base Plate	Mild Steel	15
Top Plate	Mild Steel	15

Fasteners	M6, M5 bolts, nuts washers	17.00
Side Support	Mild steel	30
Screws		15
		291.00

16. APPENDIX E: SCHEDULE

EXAMPLE SCHEDULE FOR SENIOR PROJECT:

NOTE: STUDENTS MUST MAKE THEIR OWN SCHEDULE!!!!!!!!!!!!

PROJECT TITLE: Speed Bump Power Generator

Principal Investigator.: Osamah Abulghaith

Note: March x Finals

Note: June x Presentation

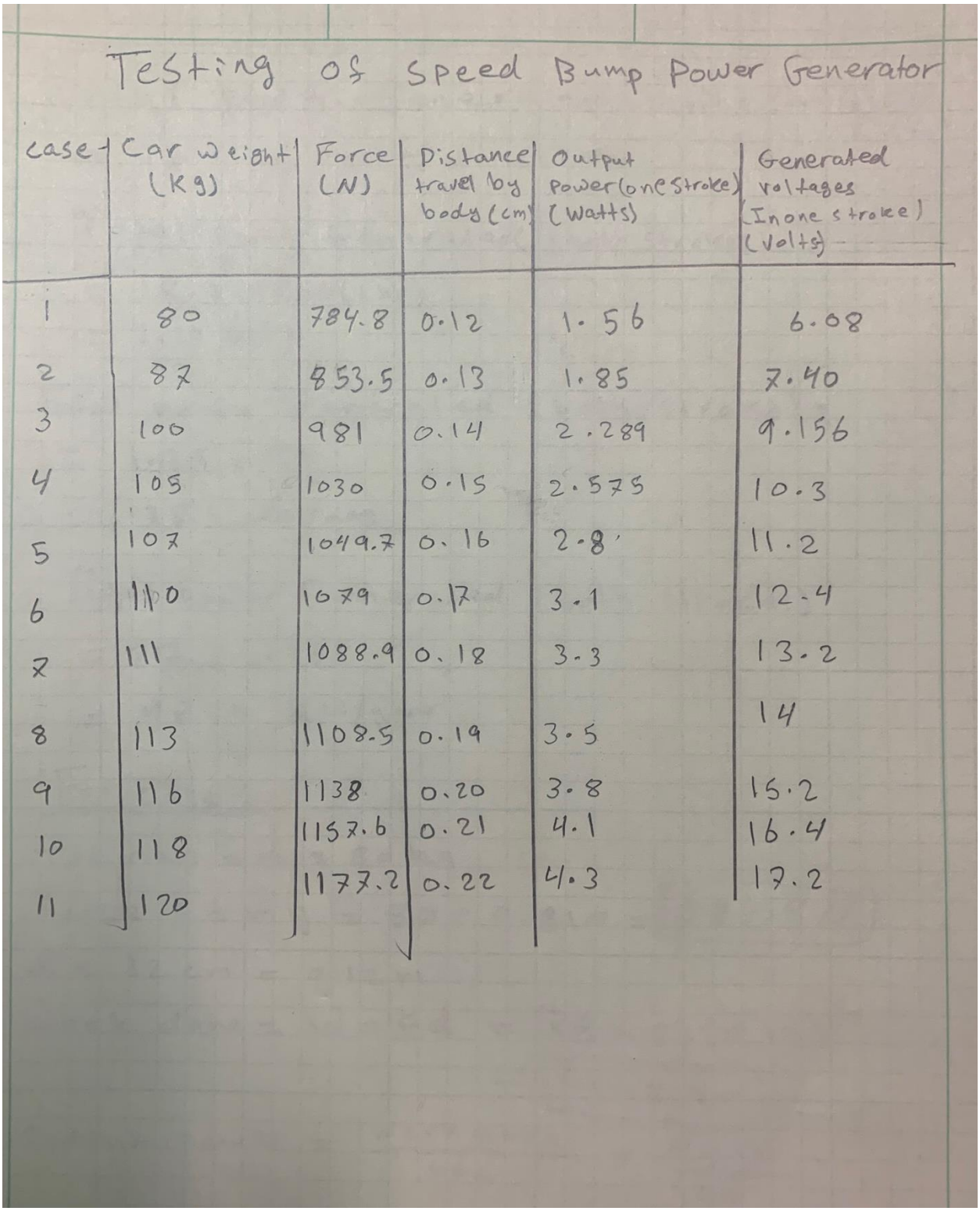
Note: June y-z Spr Finals

TASK: ID	Description	Duration Est. (hrs)	Actua (hrs)	%Cor S	October	November	Dec	January	February	March	April	May	June	
1	Proposal*													
1a	Outline	1	1.5		X X X X									
1b	Intro	2	2		X X X X									
1c	Methods & Construction	2	4		X X X X									
1d	Analysis	2	2		X X X X									
1e	Discussion	2	2		X X X X									
1f	Parts and Budget	0.5	1			X X X X					X X X X X			Started on time ended late
1g	Drawings	1	3			X X X X					X X X X			Started on time ended on time
1h	Schedule	3	3								X X X			Started late ended late
1i	Budget	1	2								X X X			Started early ended early
1j	Summary & Appx	1	2											
	subtotal:	15.5	22.5											
2	Analyses													
2a	Load Anal=>Geo	2	5		X X X X									
2b	Size Anal=>Geo	2	4			X X X X								
2c	Springs Anal=>Geo	1	3			X X X X								
2d	Kinematic => Geo	2	2.5				X X X X							
2e	Power => Geo	1	3				X X X X							
	subtotal:	8	17.5											
3	Documentation													
3a	Part 1 leg drawing	1	1		X X X X									
3b	Part 2 leg2 drawing	1	1		X X X X									
3d	Part 3 top plate drawing	1	2			X X X X								
3e	Part 4 down plate drawing	1	1			X X X X								
3g	Part 5 springs drawing	1	1			X X X X								
	subtotal:	5	6											
4	Proposal Mods													
4a	Project Schedule	1	2			X X X X								
4b	Project Part Inv.	2	3				X X X X							
4c	Crit Des Review*	2	3				X X X X							
	subtotal:	5	8											
7	Part Construction													
7a	Make Part Top Plate	2	2.5					X X X X						
7b	Make Part Down Plate	2	2.5					X X X X						
7c	Buy Part Springs	1	2								X X X X			
7d	Make Part L-Shape	1	5					X X X X						
7e	Make Part Outside Stru.	2	7					X X X X						
7f	Shaft	1	2					X X X X						
7g	Top Plate Cap	2	5								X X X X			
7h	Rod supports	3	7								X X X X			
	subtotal:	9	33											
9	Device Construct													
9a	Assembley of full design	2	3								X X X X			
9b	Assemble of springs	2	2								X X X X			
9c	Assemble of top plate	2	2								X X X X			
9d	Assemble of down plate	3	2								X X X X			
9e	Assemble of outside str.	1	2								X X X X			
9f	Update Website	2	2											
	subtotal:	12	13											

17. APPENDIX F: RESOURCES

There is not outside sources or sponsors for the project except the team members and the consultants (Professors).

18. APPENDIX G: TESTING REPORT



Testing of Speed Bump Power Generator

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9	116	1138	0.20	3.8	15.2
10	118	1157.6	0.21	4.1	16.4
11	120	1177.2	0.22	4.3	17.2

19. APPENDIX H: RESUME

Osamah Abulghaith

207 W Hailey ct
ellensburg, WA, 98926
5098594585
osamah.abulgaith@gmail.com

Education

Lane Community College, Eugene, Oregon
Associate of Science, Industrial Engineering
Graduated - December 2017

Oregon State University, Corvallis, Oregon
Bachelor's Degree, Industrial Engineering
Transferred - January 2018

Studied Different Courses in different fields of Engineering such as Computing, Designing, Solid Works, Philosophy, Safety, and Environmental Science.

Central Washington University, Ellensburg, Washington
Bachelor's Degree, Mechanical Engineering
Graduating - June 2020

Bachelor's Degree in Mechanical Engineering and a minor in Safety and Health Management.

Employment History

Nike, Riyadh, Riyadh Province
Salesman & Supervisor August 2013 - September 2014

Learned how to negotiate with customers, Communicating with managers, writing reports, making algorithms for the inventory, supervising employees, and presenting solutions for managers.

Professional Skills

Computing	Advanced
Solid Works	Advanced
Microsoft Word	Advanced
Excel	Advanced
Powerpoint	Advanced

Languages

Arabic	Native
English	Proficient

Conference

Occupational Safety and Health Administration (OSHA)

20. APPENDIX J

Prepared by: Osamah Abulghaith	Reviewed by: Approved by:

Location of Task:	Central Washington University
Required Equipment /Training for Task:	The required equipment for speed bump power generator are appropriate footwear and eye protection.
Reference Materials as appropriate:	

lPersonal Protective Equipment (PPE) Required (Check the box for required PPE and list any additional/specific PPE to be used in "Controls" section)						
						
Gloves	Dust Mask	Eye Protection	Welding Mask	Appropriate Footwear	Hearing Protection	Protective Clothing
☒	☐	☒	☒	☒	☐	☐
Use of any respiratory protective device beyond a filtering facepiece respirator (dust mask) is voluntary by the						

user.

PICTURES (if applicable)	TASK DESCRIPTION	HAZARDS	CONTROLS
	Cutting mats	**Lacerations**	Keeps hands away from blades when cutting. Use the pressure bar to hold the mat in place.
	Clean the table	Eye injury from metal debris	Wear eye protection. Do not use compressed air
	Start the drill	None foreseen	
	Feed the drill with the feed.	Injury caused by breaking the bit	Feed with the appropriate pressure. Use the appropriate bit for the type of metal. Wear eye protection.
	Align material	Cutting hand Pinching hand between welding tips	Wear leather gloves. Deburr test strips. Do not slide hands along edges. Wear gloves. Keep fingers from pinch point