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Design and Analysis of Power Generation Unit

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Abstract -*During this project our main aim is to get current employing a simplified methodology. Non-conventional energy is taking part in a really essential role now-a-days in our nation. As day by day, the necessity for energy is additionally increasing. However thanks to restricted typical energy resources we want to admit some non-conventional energy resources. The energy obtained from railway tracks is one supply of generating non-conventional energy as a result of there's no would like of fuel as associate degree input to get the output within the type of wattage and this can be done by victimisation easy gear drive mechanism. This mechanism carries the flap, rack and pinion, gears, freewheel, flywheel, DC generator, battery.*

Key Words: **energy harvesting, , non-conventional, energy, rack and pinion mechanism , gear arrangement,**

SOLIDWORKS,

1.INTRODUCTION

Railway becomes the biggest public transportation. Railways are frequently selecting individual convenience systems and are developing various comforts and are creating easy operations for safety. one in all the systems within the world of transportation is Railways, that carries significant masses next to shipping. the masses is also within the type of passengers or consignment. Railway becomes the most important public transportation. Once a train moves over the track, the track deflects vertically owing to load exerted by the train's bogies. The vertical displacement of the track to a lower place the load of a passing train can connect regenerative devices i.e. a vibration energy harvester. The generated power is unbroken into the battery and accustomed power track side instrumentality. Railroad energy gathering is no trivial disturbance. Energy could be a crucial input in all the sectors of any country's economy. The every day increasing population and decreasing customary sources for power generation, provides a need to assume non-conventional energy resources. throughout this project we have a tendency to tend to get electrical power by running the train on the railway track. It does not would like any fuel input to come back up with wattage as output. The number of vehicles on road is increasing apace and if we have a tendency to convert a number of the K.E. of those vehicle into the movement motion of roller then we will manufacture extensive quantity of electricity At the entry or exit of the automotive parking at looking malls or theatres the facility generation unit are often put in which may end in generation of the electricity. As day by day there's a lot of would like of electrical power. victimisation this kind of technique we will generate electricity from non- typical resources moreover.

1.1 Objective

i. To design and analyze the power generation unit for electricity generation.

ii. The main focus of this arrangement is the harvesting of a large amount of power using simple gear drive mechanisms.

iii. To produce electricity by using non-conventional energy sources and utilize it for various purposes.

1.2 Block diagram

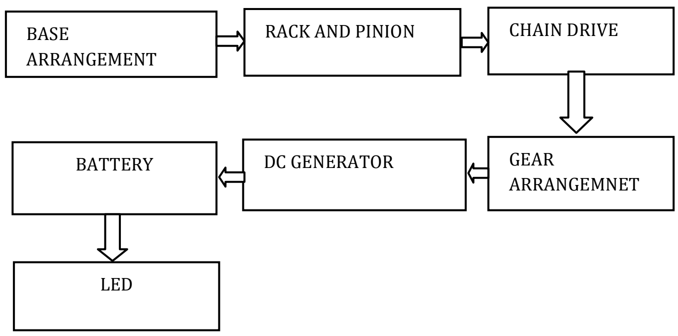

Fig -1: Model block diagram

1.3 Components

i. Rack and pinion mechanism

Rack & pinion used a movement motor to have an effect on the linear motion via a rack & pinion combination. they're used oftentimes in long travel applications that need high stiffness & accuracy.

ii. Belt drive

A drive belt could be a versatile loop of rubber, or alternative similar material, that's accustomed connect 2 or a lot of pulleys. These belts ar accustomed transfer power from the crank or cam shaft to the generator, steering mechanism pump, and numerous alternative accessories.

iii. Return spring

A come back spring could be a spring in a very key switch that keeps the switch open till it's ironed and returns the slider to its home position when the switch is free. generally this can be a whorled (standard spiral) spring.

iv. Dc generator

An electrical generator could be a device that converts energy to current, usually victimisation magnetism induction. The supply of energy is also a reciprocal or rotary engine external-combustion engine, water falling through a rotary engine or waterwheel, an interior combustion engine, a turbine, a hand crank, or the other supply of energy.

v. Shaft

In the present model 2 shafts is employed. One is employed to mount the gears. each the shaft has been mounted on bearings to supply for resistance free rotation concerning its own axis. the masses working on the shaft ar that of the weights of the parts mounted on the shaft, transmission masses and self-weight of the shaft.

vi. Battery

To charge electric battery from AC we want a stepdown electrical device, rectifier, filtering circuit, regulator to take care of the constant voltage then we will offer that voltage to the battery to charge it. assume if you have got solely DC voltage and charge the lead acid battery, we will jazz by giving that DC voltage to a DC-DC transformer and a few further electronic equipment before giving to the lead acid battery.

2. METHODOLOGY

When a train or any vehicle moves over the track or road , the load acted upon the flap over the track or plant setup is transmitted to rack, pinion and belt drive arrangements.

Where the reciprocating motion of the path of the vehicle is converted into rotary motion with the help of rack and pinion arrangement.

Then this rotatory motion is then fed on to the gear drives which supply this motion to the other shaft where the belt drive is located.

This speed which is sufficient to rotate the rotor of a generator is fed into the generator where an electromotive force is produced that generates electricity.

This electrical power can be stored in a battery.

In this way electricity is generated using this power generation unit.

3. CALCULATIONS

i. Design of frame:

Consider maximum load on the frame to be W=50 kg Force = W*g =490.5N

Syt =250 MPa

F.O.S. = 5

Maximum bending moment =Force *(perpendicular

distance of square bar length)

= 269775 N-mm

$\sigma allow$= Syt / F.O.S.

= 50 MPa

$\sigma b \leq \sigma allow$

Thus we consider, σb = 50 MPa

σb = (M*y)/b

b=d= 34.87 mm

so.

for design purpose we have considered,

b=d= 35mm

σb= Bending stress

M= bending moment

I = Moment of inertia

y= Distance of the layer at which the bending stress is consider

Syt= yield stress

$\sigma allow$=allowable stress for material

ii. Design of spring:

Diameter of wire(d)=10 mm

Mean diameter of wire(D)=85 mm

$C = \frac{D}{d} = 8.5$

$K_S = 1 + \frac{1}{2C} = 1.05882$

Assuming carbon steel material of spring

Modulus of rigidity(G)= 77 GPa

Modulus of elasticity(E)=210GPa

maximum allowable shear stress is **τ** = 350 Mpa

$$\tau = \frac{(8*K_s*F_{max}*D)}{(\pi*d^3)}$$

F_{max}= 1527.16 N

K_s= Shear stress factor

F_{max} =maximum load that spring can handle before failure

Deflection in the spring is given by,

$$\delta = \frac{8*F*n*D^3}{Gd^4}$$

n = no. of active coils = 23

δ = 35 mm.

Length of Spring

$L_s = nd$

$L_f = L_s + 1.15\delta$

= 270 mm

Free length of Spring = 270 mm

L_f = free length of spring

L_s = solid length of spring

δ = deflection of spring

iii. Design of Rack and pinion:

Rack

mR = 1.5

Addendum of Rack (AR) = 1mR = 1.5 mm

Pinion:

mp = 1.5

pressure angle (ϕ)= 20°

To avoid interference on pinion minimum no. of teeth required are given by,

$t = [2*A_R] / [\sin \phi]^2$

$t_p = 26$

v_1= Initial velocity of rack

v_2= Final velocity of rack

F= Force on the rack

m_R= module of rack

t_P = No. of teeth on pinion

$D_P = m_P * t_P$

D_P = 39 mm (pitch diameter)

Face width:

σ =

P_d = No. of teeth / pitch diameter

$Y = 0.154 - \frac{0.912}{T}$

f= 9.36 mm

Torque acting on the pinion

$T= F\ (D_P/2)$

T= 2.58 N-m

$$\text{Power} = \frac{\text{time*deflection}}{\text{force}}$$

$P= T * \omega$

N= 65.14 rpm

f= face width

Y= lewi's form factor

P_d = Diametral pitch

m_P = Module of pinion

D_P= Diameter of pinion

iv. Design of Shaft

For calculating diameter of shaft:

maximum allowable shear stress is **τ** = 350 MPa

Torsional shear stress, $\tau = \frac{16*T}{\pi*d^3}$

d= 3.95 mm

Taking, factor of safety=5

d = 3.95 * 5 = 19.75 mm

For design purpose , Diameter of shaft d = 20 mm T= Torque

d= Diameter of shaft

v. Generator:

N1 = 65.14 rpm

V.R = 2.667

N2 = N1 * V.R

N2 = 173.72 rpm

Based on availability in market we selected 400 rpm generator

A pair of gear is used to raise rpm from 173.72 to 400

Minimum no. of teeth on gear to avoid interference is 18 (T3 = 18)

$\frac{N_4}{N_3} = \frac{T_3}{T_4}$

$T_3 = 41.42$

$T_3 = 42$

$N_3 = 173.72$ rpm

$N_4 = 400$ rpm

$T_4 = 18$

3.1 Material selection

Sr no.	Component	Material
1	frame	mild steel
2	spring	carbon steel
3	rack and pinion	cast iron
4	gear	stainless steel
5	shaft	mild steel

Table -1: material selection

4. MODELLING OF PARTS IN SOLIDWORKS

1. Rectangular pipe

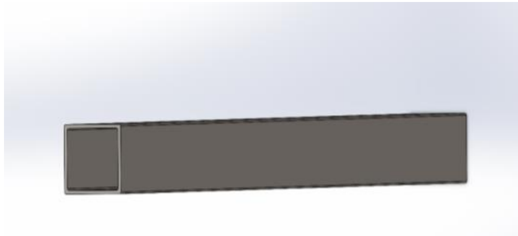

Fig -2: rectangular pipe

specifications of rectangular pipe -

for base and railway track arrangement of cross-sectional area 35×35mm2.

2. Shaft

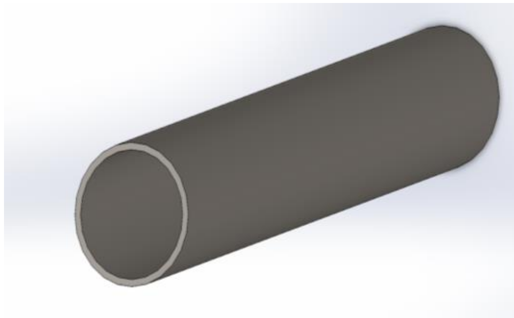

Fig -3: shaft

We are using two shafts. One is used to mount the gears. The other one is used to transmit the power.

3. Pinion

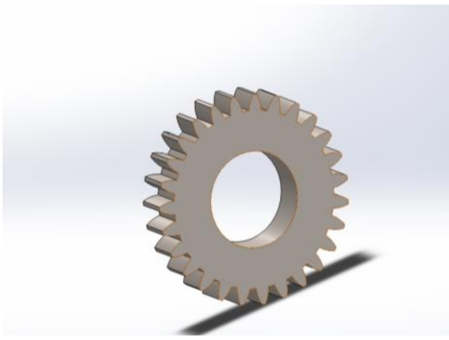

Fig -4: pinion

specifications of pinion -

Pressure angle - 20

Face width - 5.64

Module - 1.5

Number of teeth - 26

Tooth thickness - 2.38

Whole depth - 3.268

Nominal shaft diameter – 20

4. Rack

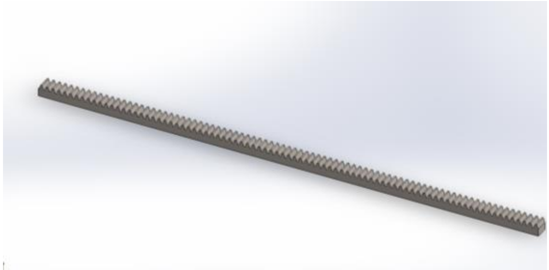

Fig -5 rack

specifications of rack -

Pressure angle - 20

Module - 1.5

Face width - 10

Pitch height -7.5

Length - 400

5. Belt drive

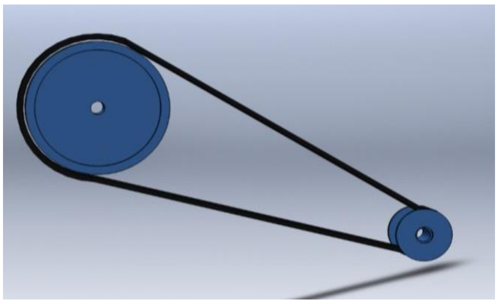

Fig -6 belt drive

specifications of belt drive -

1) Big pulley

Outer diameter- 200 mm

Inner Diameter- 20mm

Thickness - 60mm

2) Small pulley

Outer diameter- 40

Inner Diameter- 20mm

Thickness - 60mm

3) Belt thickness - 40mm

4) Belt length - 1140.96

6. Base

Fig -7: base arrangement

specifications -

Length of the base – 1100mm

Width of the base – 900mm

Height of the base – 800mm

5. CAD MODEL IN SOLID WORKS

We had designed this project model in SOLIDWORKS.

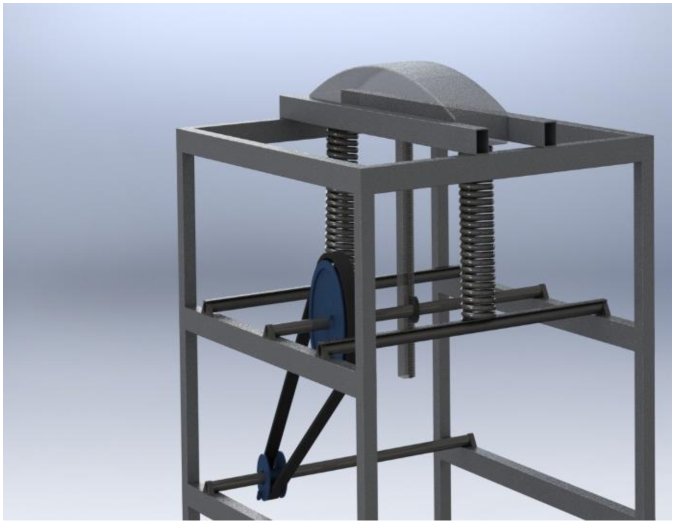

Fig -8

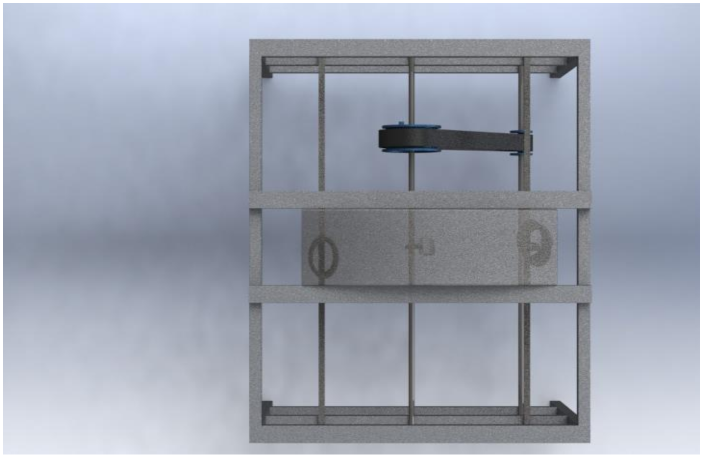

Fig -9

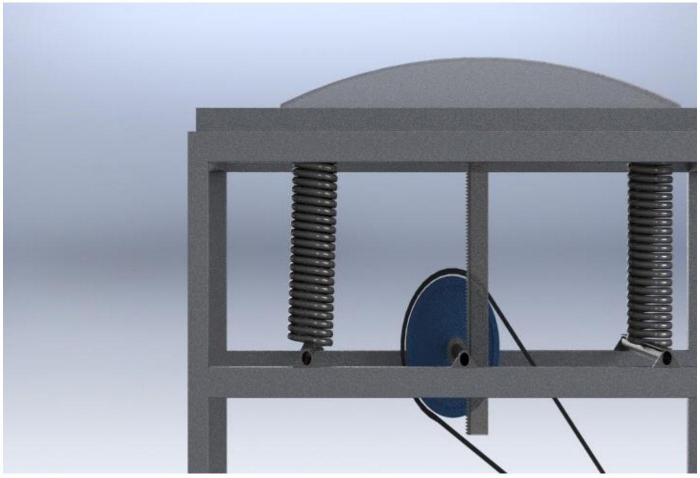

Fig- 10

5.1 Weight analysis :

Component	Weight (grams)	Quantity	Total weight (grams)
Rectangular 1100mm pipes	2558.6	8	20468.8
Rectangular 800mm Pipes	1860.77	4	7443.08
Rectangular 900 mm Pipes	2093.37	4	8373.48
Circular 900mm Shaft	422.14	4	1688.56
Curved Surface	99751.19	1	99751.19
Spring	3773.64	1	3773.64
Rack	80.76	1	80.76
Pinion	26.47	1	26.47
Big Pulley	3406.23	1	3406.23
Small Pulley	149.02	1	149.02
Belt	544.57	1	544.57
Total Assembly			150428.05

Table -2: weight analysis of model

6. ANALYSIS

The static structural analysis of the model is done in ANSYS software.

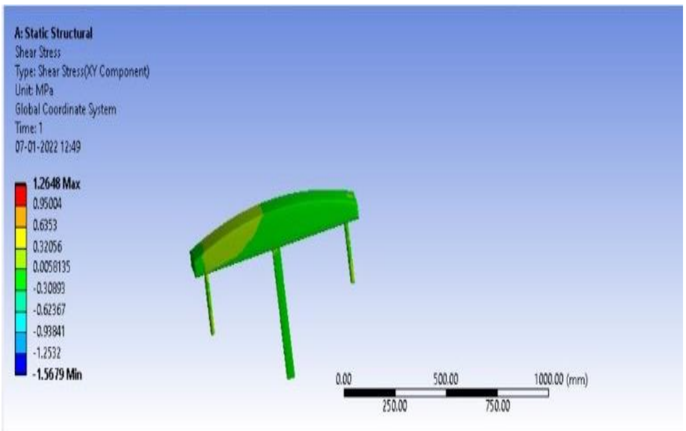

Fig -11: shear stress analysis

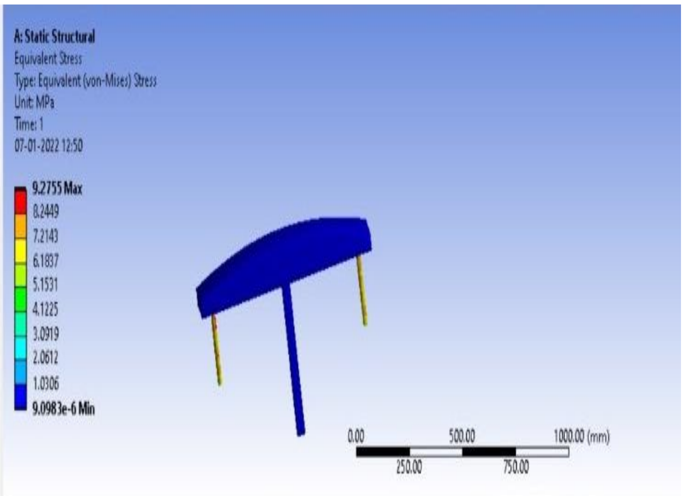

Fig -12: equivalent stress analysis

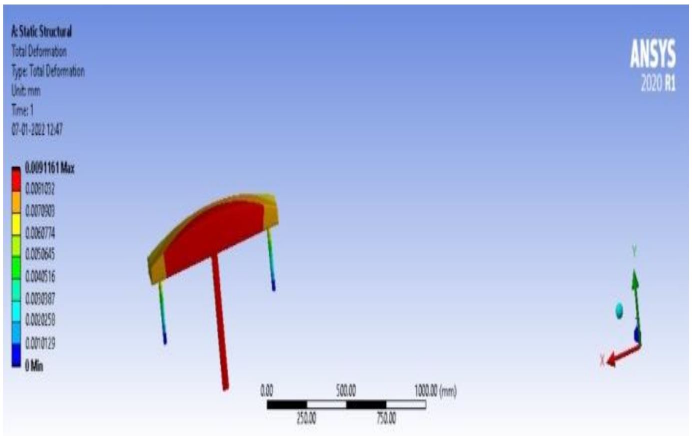

Fig -13: total deformation

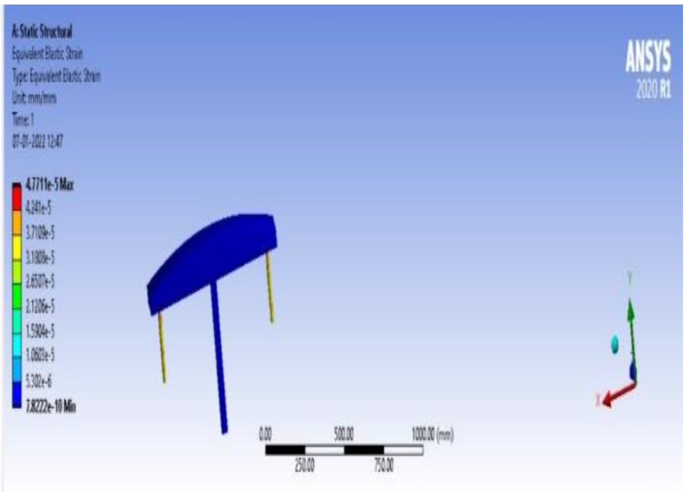

Fig -14: equivalent elastic strain

7. APPLICATIONS

Power generation unit may be utilized in all railway tracks further as 1. At the entry and exit of the automotive parking of the shops a similar system may be accustomed generate the electricity. 2. All highways road speed breakers.

7.1 Future scope

1. This arrangement is slightly changed to construct in foot step and this arrangement is mounted in

- Schools,
- Cinema theatres,
- Searching advanced
- Several alternative jammed areas

2. Future aim of the analysis is to develop our country by enriching it in utilizing its sources during a a lot of helpful manner for railroad further as domestic applications. there's associate degree ever increasing demand for energy in spite of inflation of oil and alternative fossil fuels. this idea can facilitate to boost a lot of power generation.

3. This may be created a lot of compact thus on be utilized in Speed Breakers.

8. CONCLUSIONS

1. During this project electric power was generated by employing a rack and pinion mechanism.
2. This sort of power generation is known to be cheaper than several alternative alternatives and therefore the model has less variety of elements and therefore the assembly would value terribly less with all the elements being offered often and no model specific elements square measure to be factory-made.
3. Within the analysis is it discovered that most equivalent stress is nine.2755 MPa
4. The deformation was discovered to be a most of zero.0091161 mm.

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