POWER GENERATION USING FOREARM MACHINE.

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ABSTRACT

This project is to design and fabricate a forearm machine that can generate electric energy by using human energy during exercise. Man has needed and used energy at an increasing rate for his sustenance and wellbeing ever since he came on earth for few million years ago. Due to this lot of energy resources have been exhausted and wasted. Proposal for the utilization of waste energy of power generation by gym equipment (forearm machine) is very much relevant and important for highly populated countries like India the people are crazy about gym. In this project we are generating electrical power as non-conventional method by simply pull up and pull down the equipment present in gym like forearm machine, weight pull down machine, leg extension machine etc.

We hereby make use of an energy harvester system that moves in response to movement of the motion of an forearms exercise machine for converting kinetic energy of the forearms exercise equipment into electrical power. Our system makes use of the gripping rod connected to spring based motorized mechanism having rack pinion arrangement and multiple motors to power the system and generate power. The system aims to provide resistance to forearms movement while generating power from the same thus serving dual purpose.

Keyword: - *Non-Conventional Method, Kinetic Energy, Electrical Energy, Rack, Pinion, Dual Purpose*

1. INTRODUCTION

Energy is everywhere and drives everything. Our modern lives, both individual and societal, are highly dependent on energy. It is the motive force within our bodies, propelling our vehicles, lighting our world. Consider a dead cell phone battery; living without energy, for even ten minutes, it says how important it is on daily activities. At the same time, the rate of consumption of energy is increasing day by day. If this continues, we will be left out with no energy sources in future. As a result, the scientists are now searching for the development of sustainable green energy sources like biomass, wind energy, solar energy, hydro power, tidal power, and human power.

We need to think in such a way that how the energy demand of the world can be fulfilled. Pull up pull-down power is the transfer of energy from a human source through the use of rack and pinion system. This technology is most commonly used for gym center or house. less commonly gym power is used to power agricultural and hand tools and even to generate electricity. Some application includes battery charge home appliance. Whenever the person is allowed to pass over the gym pull up pull down. As the spring are attached to gym equipment, they get compressed and the rack, which is attached to, the bottom of the rod moves down reciprocating motion of rack in to rotary with certain RPM these shafts are connected through a chain drive to the dynamos, which converts the mechanical energy into electrical energy.

The main causes of mechanical vibration are: -

- To use the human efforts for the generation of electrical energy.
- To find the new sources of renewable energy.
- To provide the resistance to exercise movement while generating power from the same thus the serving dual purpose.
- To create renewable form of energy (electrical energy) by the gym equipment by attaching the dynamo in the gym pull up system.
- To make the project flexible enough so that multiple exercises can be performed in single setup.
- To change the traditional way of doing gym and losing the human energy at no cost.
- To construct the new gym, pull up setup in very simple and effective way.

2. METHODOLOGY

Human work is converted into mechanical motion with the help of various mechanical parts. Then this mechanical motion is transferred to shaft and it convert into shaft motion the shaft is coupled with DC motor and DC motor is coupled with battery to store electricity and drive from the battery when it needed

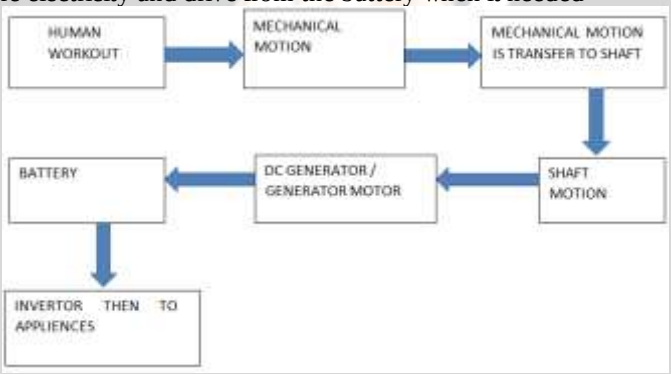


Fig -1: Flowchart of methodology

3. FRAME MATERIAL STRENGTH SELECTION

Cantilever Beams are members that are supported from a single point only; typically, with a Fixed Support. In order to ensure the structure is static, the support must be fixed; meaning it is able to support forces and moments in all directions.

Sample Cantilever Beam equations can be calculated from the following formulae, where:

Bending stress formula

$\sigma = My/I$

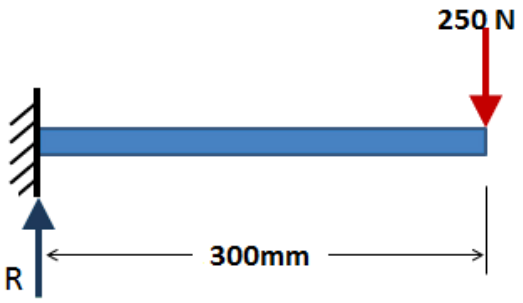
Where, σ = bending stress

M = bending moment (which is calculated by multiplying a force by the distance between the point of interest and the force),

y= The distance from the neutral axis

I= Moment of inertia

3.1 CANTILEVER BEAMS AT SQUARE SECTION



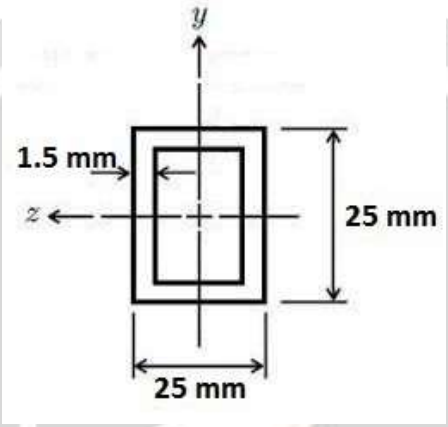


Fig -2: Cantilever Beams at square section

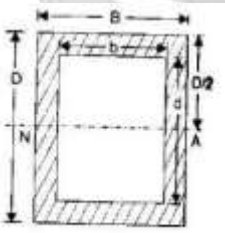
- Load(W) = 250N
- Member Length(L) =300 mm
- Thickness(T) = 1.5 mm
- The distance from the neutral axis (y) =12.5 mm
- Width (B) = 25 mm
- Depth (D) = 25 mm

For Circular hollow section

$$I = \frac{BD^3}{12} - \frac{bd^3}{12}$$

$$y_{max} = \left(\frac{D}{2}\right)$$

$$Z = \frac{1}{6D}[BD^3 - bd^3]$$



- $I=\frac{25\cdot 25^3}{12} - \frac{22.5\cdot 22.5^3}{12}$
-
- I=390625−256289.0625I=390625−256289.0625

-
- I=11419.6614
- Y=12.5 mm
- MA -250*300 =0
- MA= 75000 N.mm
- $\sigma=\frac{MY}{I}$
-
- $\sigma=\frac{75000 \cdot 12.5}{11419.6614}$
-
- $\sigma=82.09 N/mm^2$

As the value $\sigma=82.09$ N/mm ^{2} is lower than Ultimate tensile strength we can use the square tube to manufacture the complete structure.

3.2 SPRING CALCULATIONS:

Assumptions: Job Weight = 30 Kg Deflection of spring () = 360 mm

Iterative method to find Wire Diameter (d)

i. Permissible Shear Stress

$\tau = 0.5 \times Sut$ ..... (i)

For d=2 & grade 2 material

τ_{per}= 0.5x1720 = 860

= 860

Where, τ_{per} is permissible shear stress in N/mm ^{2} Sut

Where, τper is permissible shear stress in N/mm ^{2}

Sut is ultimate tensile strength in N/mm ^{2}

d is wire diameter of spring in mm

ii. Induced Stress

$\tau = k\left(\frac{8PC}{\pi d^2}\right)$ ..... (ii)

Take C=12 Wahl Factor

K= 1.11

τ = (1.11x8x30x9.81x12) / (4x3.14x2x2)

τ_{in} = 623.89

860 > 623.89

$\tau_{per} > \tau_{in}$

Where, C is Spring Index

K is Wahl Factor

P is load in N

ii. Mean Coil Diameter

D = 122

D=24mm

Where, D is mean coil diameter in mm

To Find No of Coils (N) Deflection

$$\delta = \frac{8PD^3N}{Gd^4} \quad \ldots\ldots\ldots\ldots\ldots\ldots (iii)$$

$$360 = \frac{8 \times 30 \times 9.81 \times 24^3 \times N}{4 \times 81370 \times 2^4}$$

N=57.56 =58

For Square & ground End

N_t= N +2

=58+2= 60 Coils

Solid Length=N x d

60x 2 =120mm

Total gap = (N_t - 1) x gap between two adjacent coils

= (60-1)x1

= 59 mm Free Length

= Solid Length + Total Gap + d

= 120 + 59 + 360

= 539 mm

Pitch

$$P = \frac{\text{Free Length}}{(N_t - 1)}$$

=539/59

= 9.13 mm

Stiffness of spring

$$k = \frac{Gd^4}{8D^3N} \quad \text{.....(iv)}$$

K = 0.1962 N/mm

For square & ground end

Where, N is no. of active coils

Nt is total no. of coils

G is Modulus of rigidity of material of spring in N/mm^2

K is spring stiffness in N/mm

Spring Specifications:

Wire diameter(d)=2mm

Mean coil diameter (D)=24mm

Total No of Coils(N)=60

Free Length= 539mm

Spring Stiffness (K)=0.1962N/mm

3.3 Design of shaft

Here,

P=Power.

N= Revolution per minute.

T= Torque/ Twisting moment.

W_{max}= Maximum load acting on shaft.

M_{max}= maximum bending moment.

τ= safe stress of shaft material.

T_{eq}= Equivalent twisting moment.

D= Diameter of shaft.

- Given: -

$P = 3 \times 10^3$

N= 120 rpm

W_{max} = 25 kg

$\tau = 160\ N/mm^2$

- By taking FOS=1.2 for safety purpose

$W_{max} = 25 \times 1.2$

$=30$ kg

$W_{max} = 30 \times 9.81$

$W_{max} = 294.3$ N

- To find out twisting moment.

$P = 2\pi NT/60$

$3 \times 10^3 = \frac{2\pi \times 120 \times T}{60}$

$T = \frac{3 \times 103 \times 60}{2\pi \times 120}$

T =238.732Nm.

- To find out bending moment.

$M_{max} = W_{max\ x} \frac{L}{4}$

$= \frac{294.3 \times 1}{4}$

$M_{max} = M = 73.575$ Nm.

- To find out equivalent twisting moment.

$T_{eq} = \sqrt{T2 + M2}$

$= \sqrt{(238.732)2 + (73.572)2}$

$= 249.812$ Nm.

$T_{eq} = 249812.426$ Nmm._____I

- To find the Diameter from T_{eq}

$T_{eq} = \pi/16\ D^3 \times \tau$_____II

- Put the value of T_{eq} from equation I to equation II

$249812.426 = \pi/16\ D^3 \times 160$

$D^3 = \frac{249812.426 \times 16}{\pi \times 160}$

$D^3 = 987.750$

- By taking cube root on both sides.

$D = \sqrt[3]{987.750}$

D = 9.959mm = 10mm.

D = 10mm

→ The Diameter of shaft is 10mm

4. Power Calculation:

The Quantity of hours the gear is utilized will be duplicated by the watts will gives us the watts hours used. The watts hours can be resolved.

As the 12 W is approx. Produced by the forearm machine at one man at one time, so

Approximately in a one-hour forearm machine produced 55W

55W * 7 hours = 0.385 kw hours

Day	Hours of Gym	Total Hours Open	Ratio	Wattage* Hours	KWh Consumed
Monday	6:30am-11:00pm	16.5 hours	Same open hours =approx. 7 hours	55 W x 7 h	385 kWh
Tuesday	6:30am-11:00pm	16.5 hours	Same open hours =approx. 7 hours	55 W x 7 h	385 kWh
Wednsday	6:30am-11:00pm	16.5 hours	Same open hours =approx. 7 hours	55 W x 7 h	385 kWh
Thursday	6:30am-11:00pm	16.5 hours	Same open hours =approx. 7 hours	55 W x 7 h	385 kWh
Friday	6:30am-7:00pm	12.5 hours	(7/16.5)=(x/12.5)= approx. 5 hours	55 W x 5 h	275 kWh
Saturday	11:00am -7:00pm	8 hours	(7/16.5)=(x/8)=approx. 3 hours	55 W x 3 h	165 kWh
Sunday	1:00pm-10:00pm	9 hours	(7/16.5)=(x/9)=approx. 4 hours	55 W x 4 h	22 kWh
				Total kWh used by Forearm mchine	2.2 kWh per week

Chart 1: Results of power consumption by Power generating forearm machine for one week.

Sr. No.	Part	Designation	Qty.	Material
1.	Rack	H=180mm W=10mm	1	EN8
2.	Pinion	D=40mm	1	EN8
3.	Sprocket	D=80mm	2	Stainless steel
4.	Shaft	D=10mm	2	Mild steel
5.	Spring	D=2mm	1	H.C.S.
6.	Bearing	D=10mm	4	Steel
7.	Dynamo with pinion	12V DC, 1000 rpm	1	----
8.	Battery	12V DC, 7.2Ah	1	----
9.	LED -Light	12V DC	2	----
10.	Frame	H=450mm, L=500mm, B=300mm	1	Steel
11.	Fly Wheel	D=200mm	1	Cast Iron
12	Fabrication and other Expenses	----	-	----

Chart 2: Cost Analysis

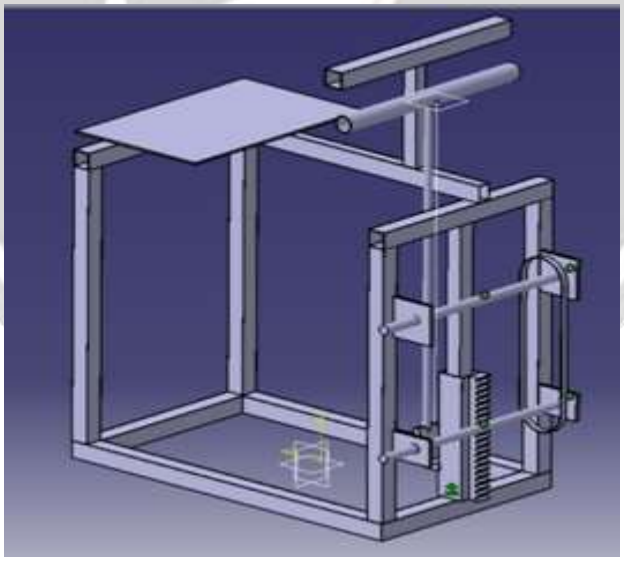


Fig 3: Catia Model

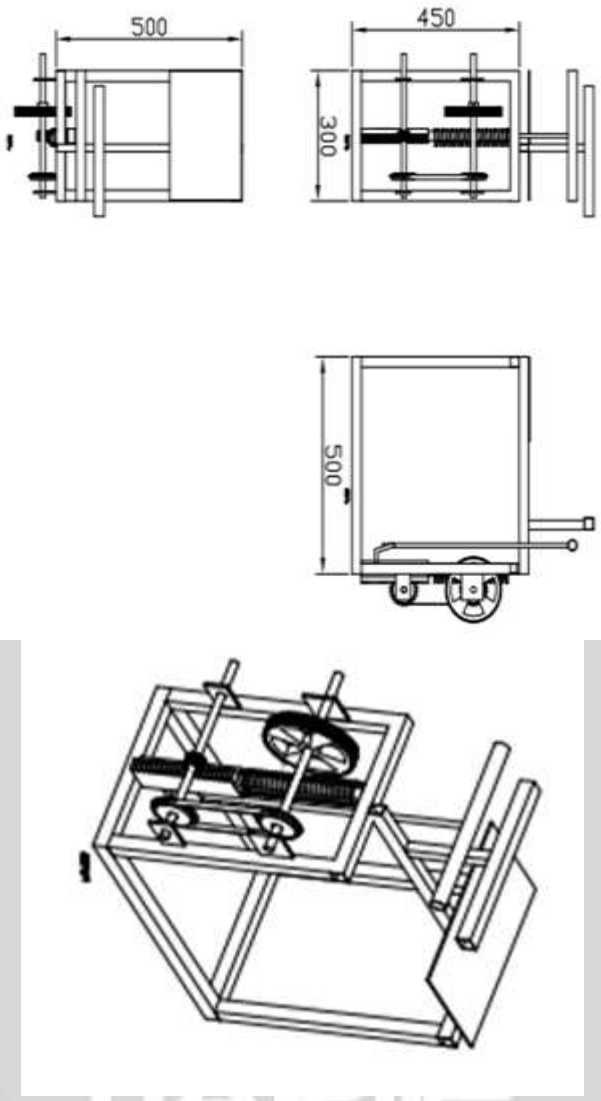


Fig 4: AutoCAD Design

5. Conclusion:

This design and implement an innovative exercise to generate electrical power for the house appliances. Energy storage is demand necessary and important within renewable energy systems to ensure stability of the system. Power generation using forearm machine works like the dual-purpose machine. It reduces not only the obesity and overweight problems of humans but also produces electrical energy. This machine no need of the any type of the fuel input. It will be very helpful for the rural areas. In this day where the world challenged to be more responsible in its sourcing of electrical power. The method of human power generation could be a solution that also helps mitigate the issue of obesity and overweight.

Advantages: -

1. It is clean and eco-friendly energy.
2. Dual benefit system.

3. Maintenance is not complicated.
4. It does not require any fossil fuel.
5. It does not produce harmful effect on environment.
6. Human health benefit.
7. Electrical energy can be stored in battery.

Disadvantages: -

1. Comparatively Less amount of power will be generated. Tread mills and stationary bicycle can produce at higher rate.
2. Mechanical moving parts are more so, chances of mechanical loss are more.
3. Weight of the model is very high so difficult to transport.
4. Initial investment is high.

Applications: -

1. Power generation using gym pulling can be used in most of places such as home, Colleges, School and Gym center.
2. It is can be used for glowing plenty of lights, charging electrical devices and can also be stored in battery which can be used for multiple purpose.

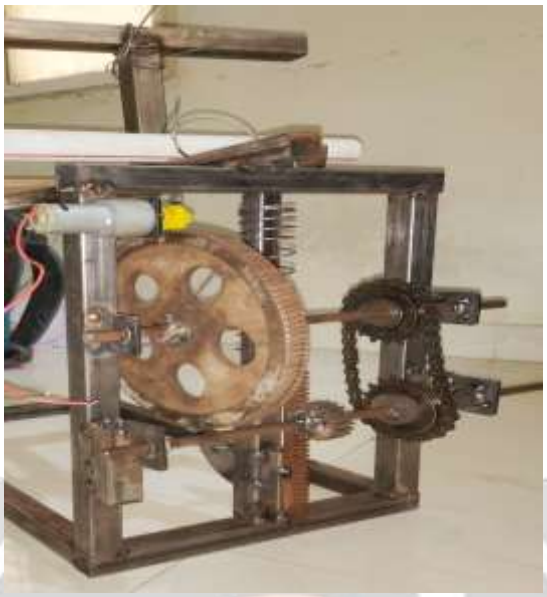


Fig 5: Pictorial View of Model.

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