An-Najah National University
Faculty of Engineering
Department Of Mechanical Engineering

Electricity Generation Using Speed Breakers

Submitted by:

Ahmad Beshara

Bilal Hawawra

Kareem Ahmad

Renad Daqqa

Submitted to :

Dr. Iyad Assaf

Outline

1. Introduction .
2. Objectives .
3. Problem statement
4. Methodology
5. Result and analysis .
6. Recommendation and Conclusions

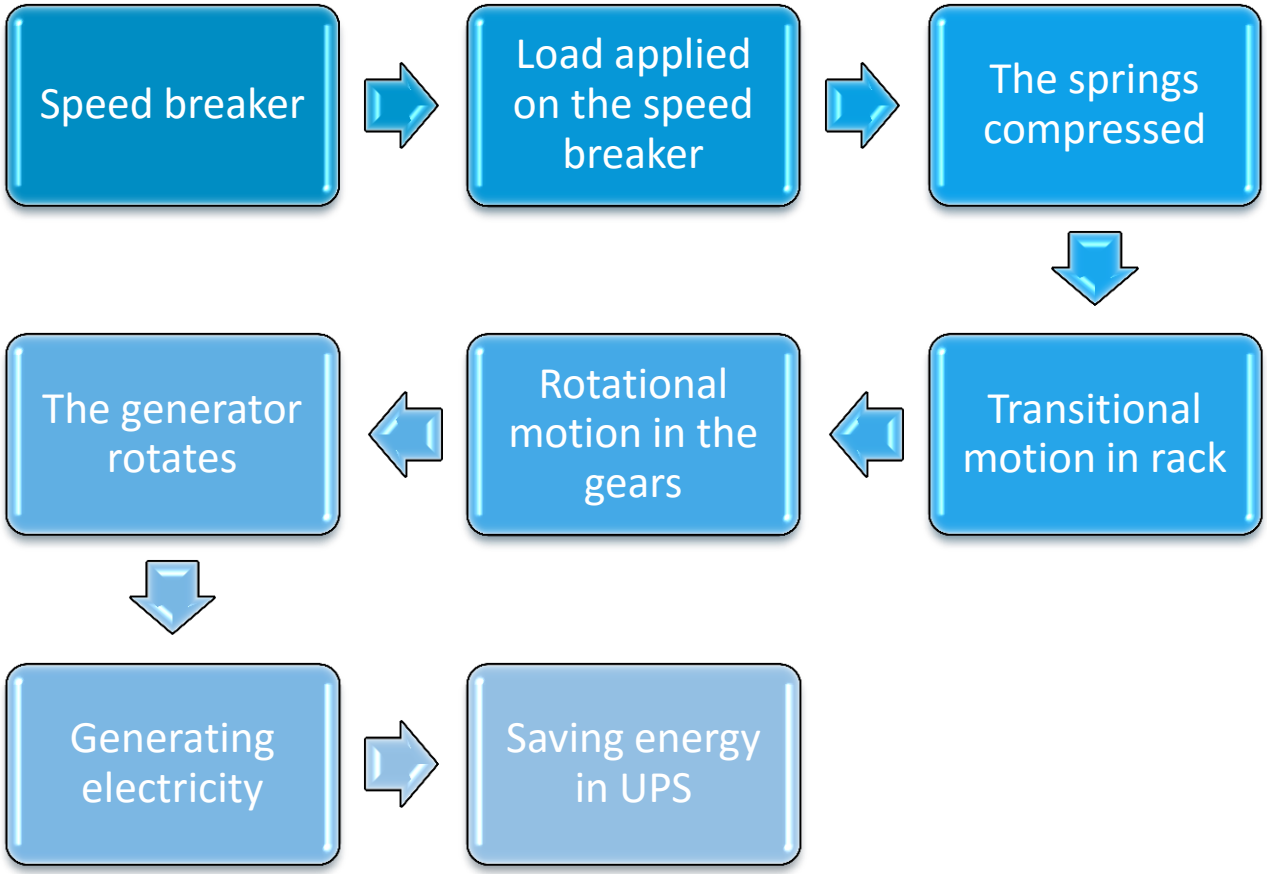
Introduction

Electricity generation depends mainly on coal, coal burning produce a large amounts of carbon.

The power sources in our world are in continuous decreasing.

Our project provides a new clean source of energy. The speed breaker is generating electricity depending mainly on car's weight by converting the kinetic energy of the moving car into electrical energy using a DC-generator, and for every car passes on the speed breaker, the generator could generate up to 72 watt.

Description of the system



Objectives of Project

To provide an environmental friendly power source.

Reducing the costs of electricity .

Producing a big amount of energy and storing it to use later when the electricity shut down.

To make cheap and easy maintainable power source.

Problem statement

Methodology

We will apply our project in Nablus ,Precisely in the city center in the front of the taxis parking lots.

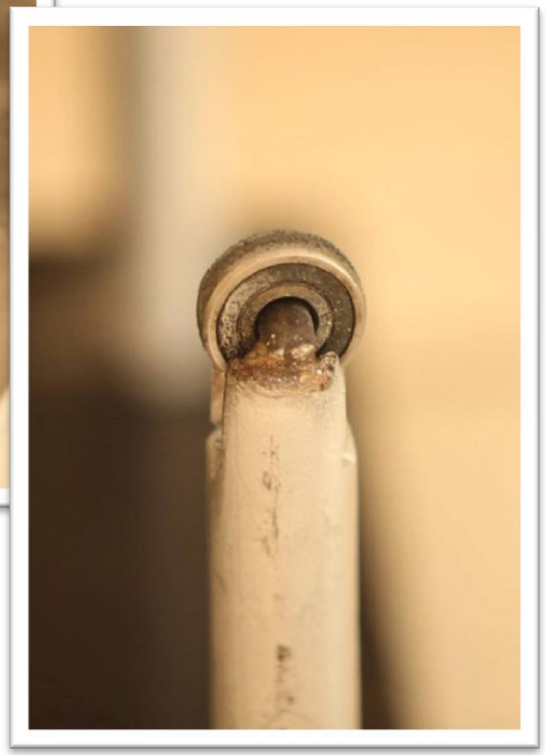
We chose this place as there is a high number of cars pass over from this region and there is often a big traffic. Also , the weight of the vehicles pass over is approximately fixed and suitable for the speed breaker ,so we make sure that failure will not occur. As a result , a high amount of power is generated and the efficiency is high .


Parts Assembly
INSTAMAG

Component

1-Spring

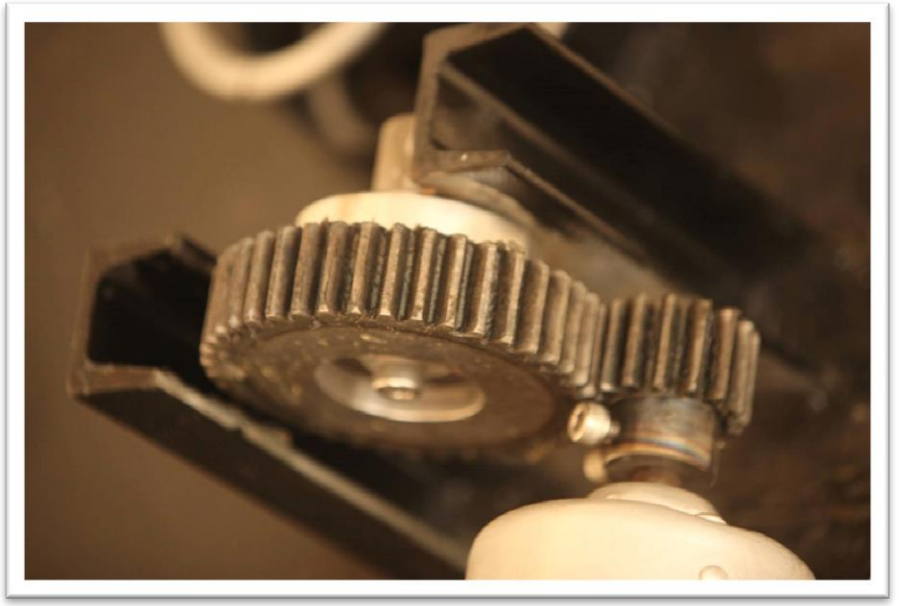
2-Angular joint & wheel



Component

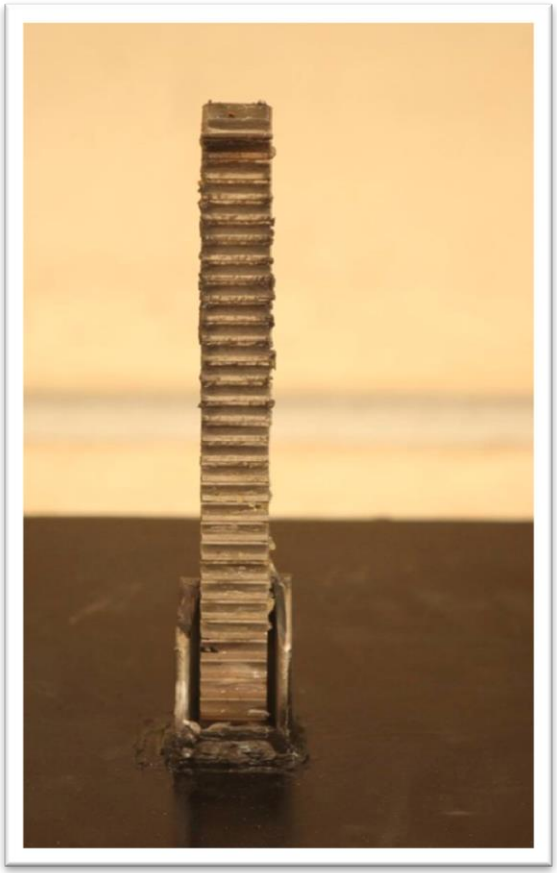
3-Hollow pipe

4- spur gear& Support guide

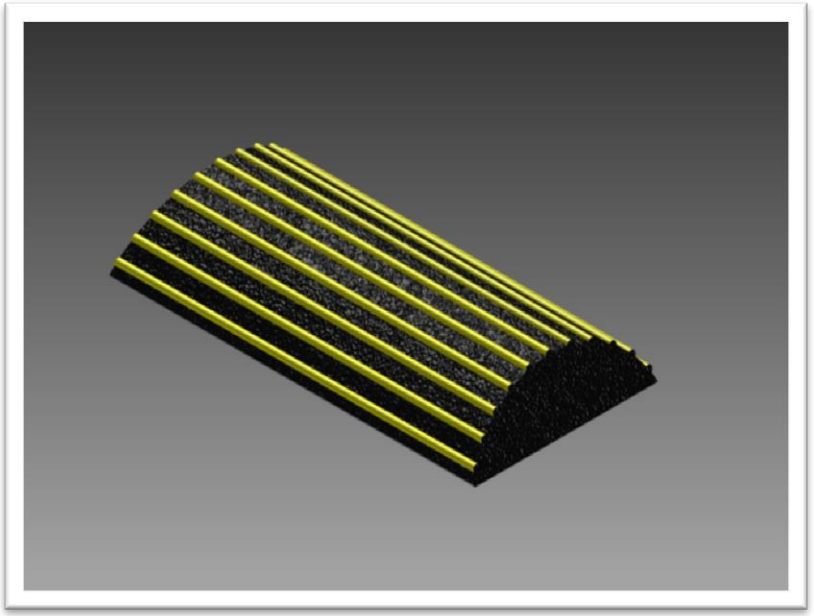


Component

5-Rack



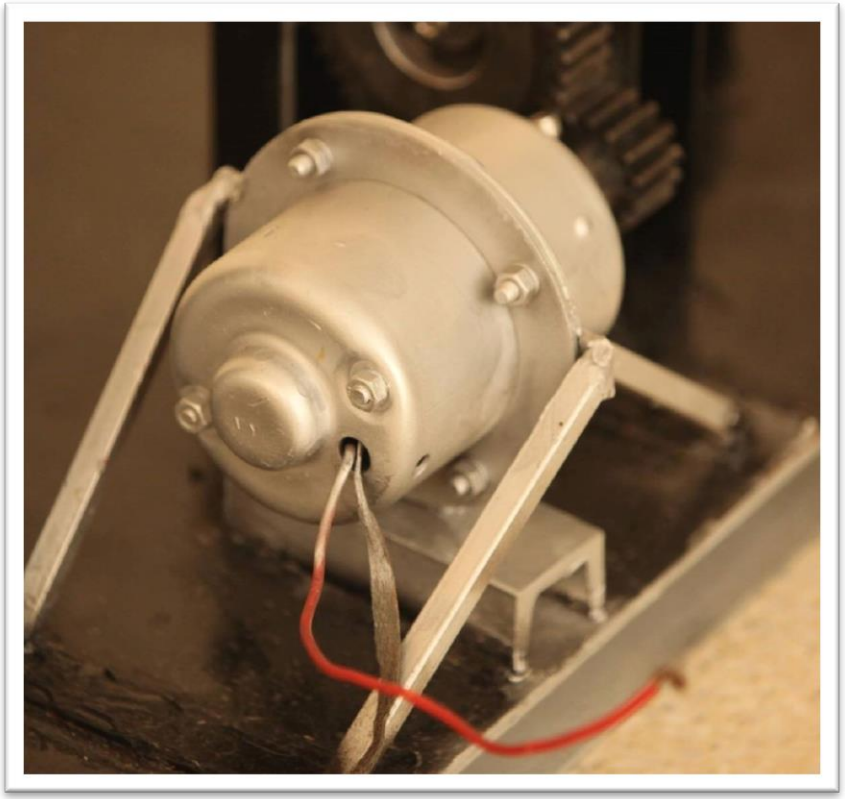
6-Rubber speed breaker



Component

7-Bolts

8-Generator



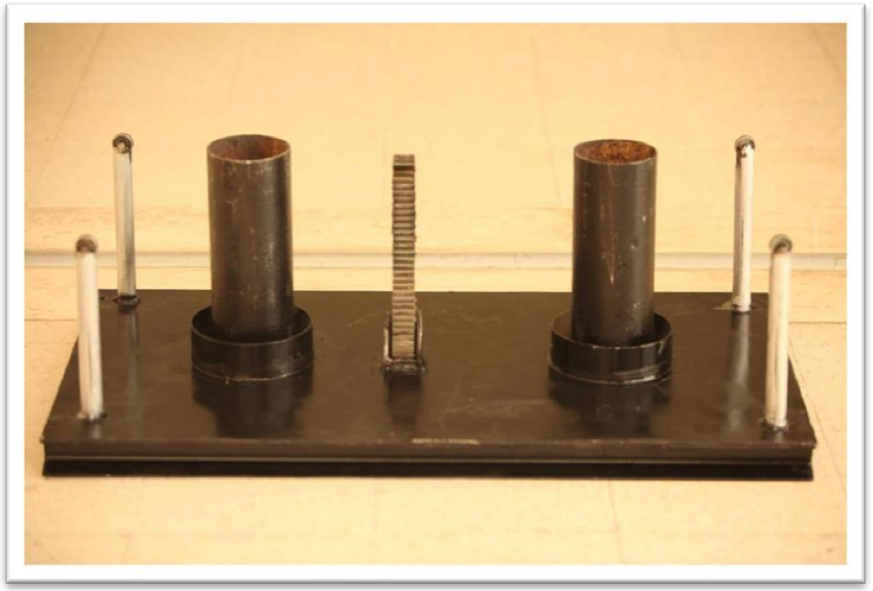
9-ups

10-invertor

11-Steel plate

Lower plate

upper plate



Material for each component:

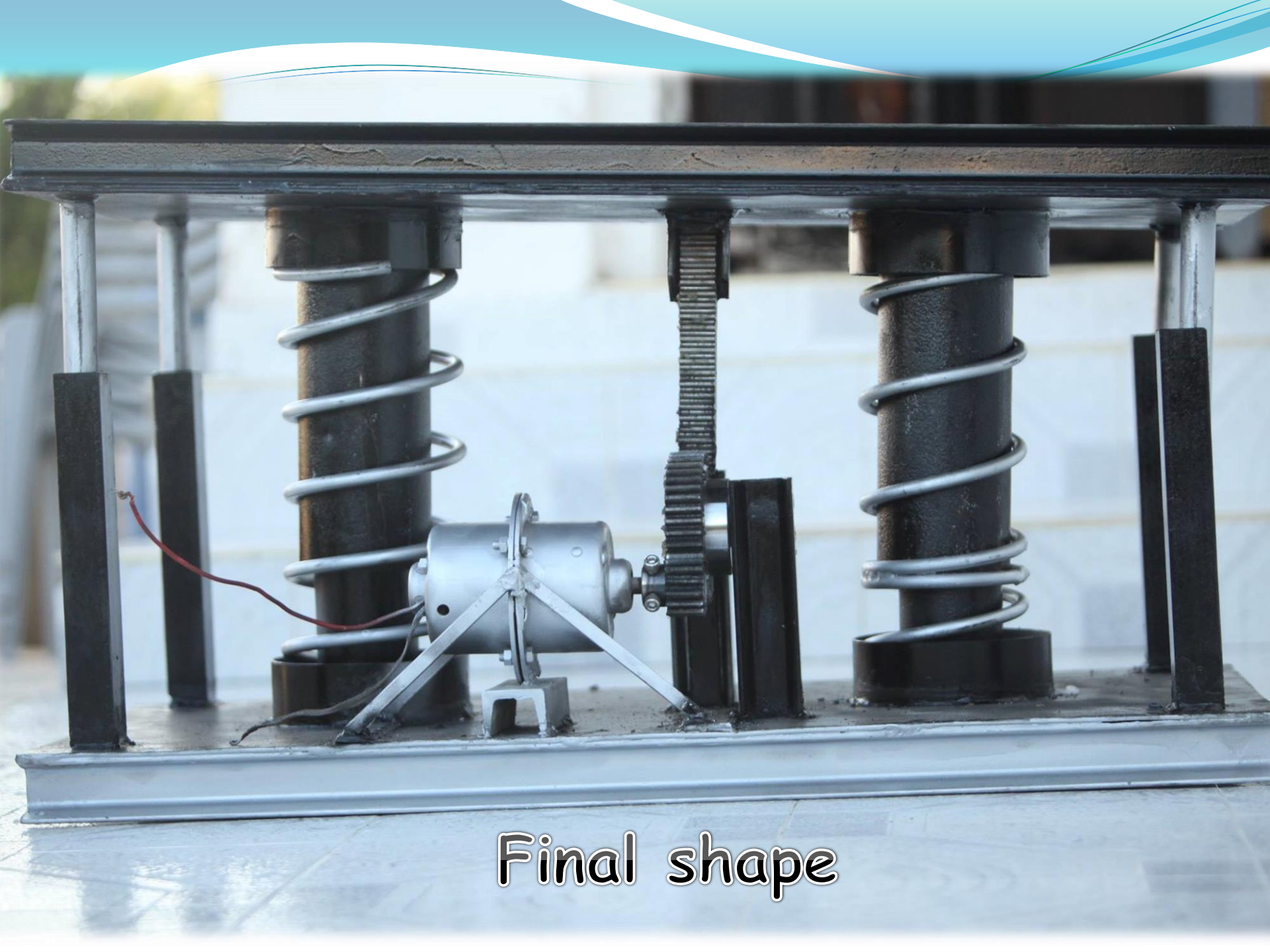
Steel material :

Steel is a strong material that is highly resistant to shaping at normal temperatures but this resistance lessens considerably at higher temperatures

- Type of steel : 4140 is a 1% chromium - molybdenum e high tensile steel
- this type of steel has a high fatigue life and it can be used for heavy duties
- This material used for plate, gear, bolts, angular joint, support guide block, and Hollow pipes

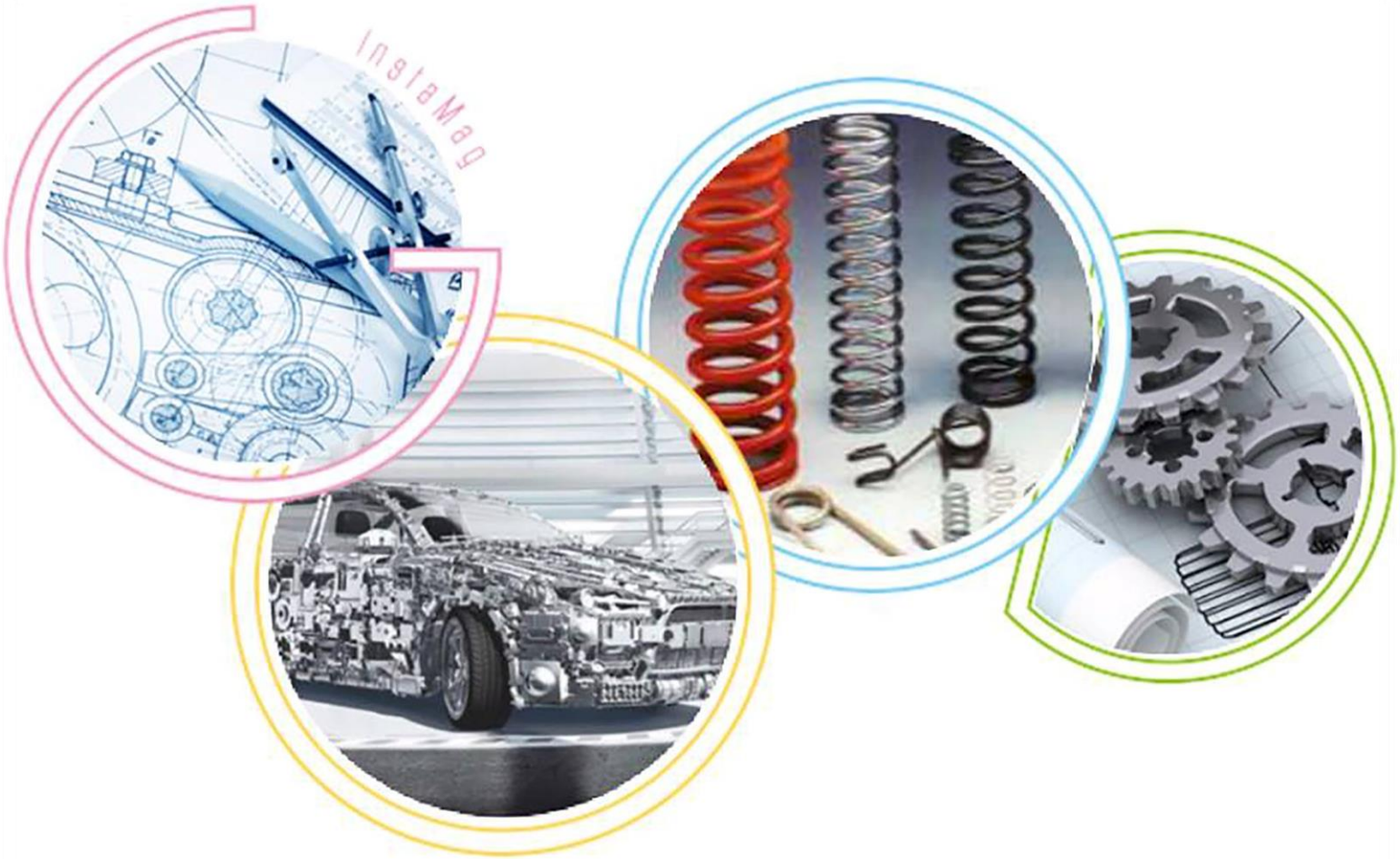
Chrome-vanadium:

- The material will be used is Chrome-vanadium (UNS G61500, AISI 6150 M ASTM 231-41).
- This is the most popular alloy spring steel for condition involving higher stresses than can be used with the high-carbon steels and for use where fatigue resistance and long endurance are needed.
- Also good for shock and impact loads
- This material used for spring.


Final shape

How the project work

Result and analysis



Parameters

(Na) Number of active coils.

(Nt) Number of total coils.

(OD) Outside diameter.

(Lo) Free Length

(Ls) Solid Length.

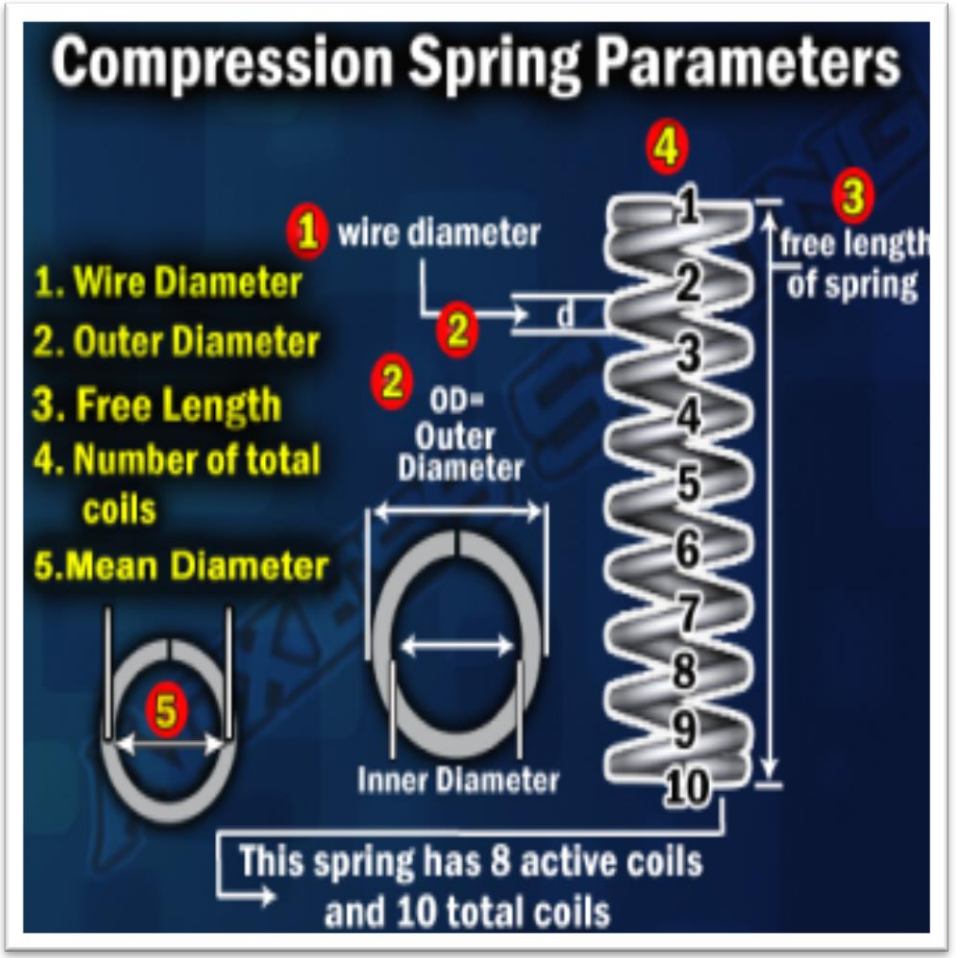
(C) Spring index.

(D) Mean diameter.

(d) Wire diameter.

(K) Spring Rate.

(P) Pitch : distance between coil.



Calculation:

The calculation depend on :

weight (maximum) = 2000 kg
Fmax = 2000 * 9.81 = 19620 N

weight (minimum) = 1200 k
Fmin = 1200 * 9.81= 11772 N
But etch spring will have (F /2) = 11772/2 = 5885 N
Material of spring Chrome-vanadium, squared and ground
F = 5885 N
G = 77200 Mpa
Lo = 500 mm
Ymax = 150 mm
d = 18 mm
D = mm
From table (10-4) [1]
A = 2005
m = 0.168

Equations that are used :

$$S_{ut} \quad \frac{A}{d^m}$$

$$S_{sy} = k_B(S_{ut})$$

$$D = \frac{S_{sy}\Pi d^3}{8n_s(1+\xi)F_{max}}$$

$$OD = D + d$$

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

$$L_s = dNt$$

$$K = \frac{F_{max}}{Y_{max}}$$

$$N_a = \frac{Gd^4Y_{max}}{8D^3F_{max}}$$

$$N_t = N_a + 2$$

$$L_0 = L_s + (1+\xi)Y_{max}$$

$$P = \frac{L_0 - 2d}{N_a}$$

we choose a suitable wire diameter to satisfy the standard dimensions (the free length and the solid length , more logical and more safe)

d	10	11	12	13	14	15	16	17	18
Sut	1361.8	1340.2	1320.7	1303.1	1287.0	1272.1	1258.4	1245.7	1233.8
Ssy	612.8	603.1	594.3	586.4	579.1	572.5	566.3	560.5	555.2
D	29.6	38.8	49.6	62.3	76.8	93.4	112.1	133.1	156.5
OD	39.6	49.8	61.6	75.3	90.8	108.4	128.1	150.1	174.5
C	3.0	3.5	4.1	4.8	5.5	6.2	7.0	7.8	8.7
K	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5
Na	94.7	61.7	41.7	29.1	20.9	15.3	11.4	8.7	6.7
Nt	96.7	63.7	43.7	31.1	22.9	17.3	13.4	10.7	8.7
Ls	966.8	700.5	524.5	404.4	320.0	259.4	215.1	182.1	157.3
Lo	1139.3	873.0	697.0	576.9	492.5	431.9	387.6	354.6	329.8
P	11.8	13.8	16.1	18.9	22.3	26.3	31.1	36.8	43.6

Helical compression spring design for fatigue loading and fatigue life

$$S_{sm} = 534MPa$$

$$S_{sa} = 398MPa$$

$$F_m = \frac{F\max + F\min}{2}$$

$$F_m = 7847.5$$

$$\tau_a = k_B \frac{8F_a D}{\Pi d^3}$$

$$\tau_a = 155.3$$

$$S_{se} = \frac{S_{sa}}{1-(\frac{S_{sm}}{S_{su}})^2}$$

$$S_{se} = 683.1$$

$$F_a = \frac{F\max - F\min}{2}$$

$$F_a = 1962.5$$

$$\tau_m = k_B \frac{8F_m D}{\Pi d^3}$$

$$\tau_m = 620.9$$

$$S_{su} = 0.67S_{ut}$$

$$S_{su} = 826.6$$

$$k_B = \frac{4C+2}{4C-3}$$

$$k_B = 1.2$$

$$S_f = \frac{\tau_a}{1-(\frac{\tau_m}{S_{su}})}$$

$$S_f = 623.9$$

$$n_f = \frac{1}{\frac{\tau_a}{S_{se}} + \frac{\tau_m}{S_{su}}}$$

$$n_f = 1.02$$

$$a = \frac{(f * S_{su})^2}{S_{SE}}$$

$$a = 1524.4$$

$$b = \frac{-1}{3}\log\left(\frac{f * S_{su}}{S_{se}}\right)$$

$$b = -0.07$$

$$N = \left(\frac{S_f}{a}\right)^{\left(\frac{1}{b}\right)}$$

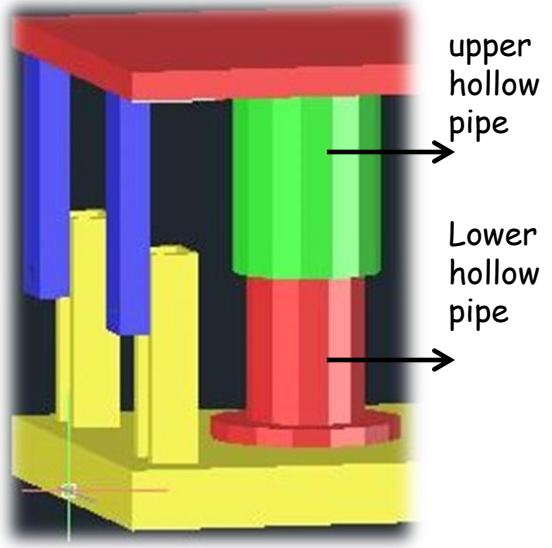
N=841382.54

every car make two cycles in the springs : one by the front wheels and the other by the back wheels , every day 500 cars pass over the speed breaker so we have 1000 cycles in the springs each day

Period that does not happened fatigue

831382.54 / 1000 * 360 = 2 year

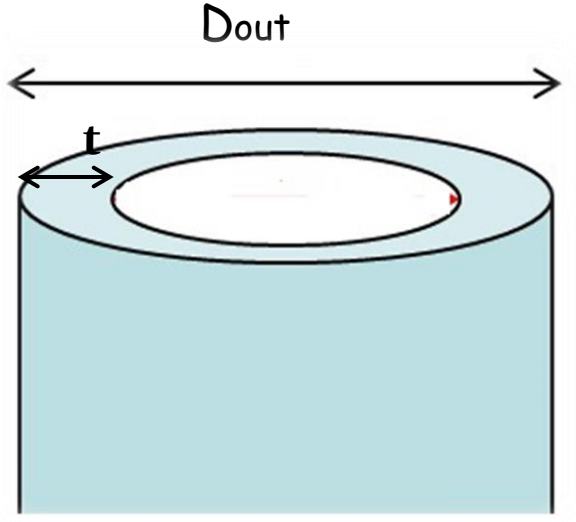
Calculation:



Din spring = D-d =156.5-18=138.5 mm

clearance between lower hollow pipe and spring = 5mm
thickness for hollow pipe = 3mm
Din(lower H.P)= Din spring - 2*clearance - 2*thickness
Din lower = 122m

clearance between upper hollow pipe and spring = 2mm
thickness for hollow pipe = 3mm
Din (upper H.P) = Din spring -2*clearance – 2*thickness
Din upper = 128 mm



Spur gear:

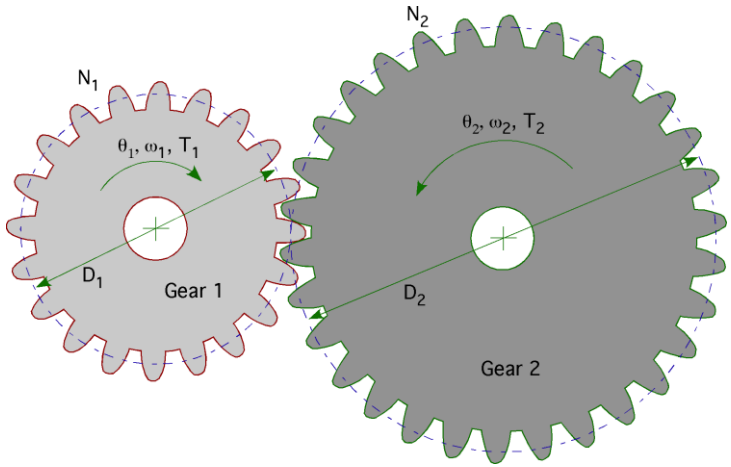
Teeth parallel to the shaft, Used to transmitted motion from one shaft to the other shaft.

(d) Pitch Diameter

(P) Diametral Pitch

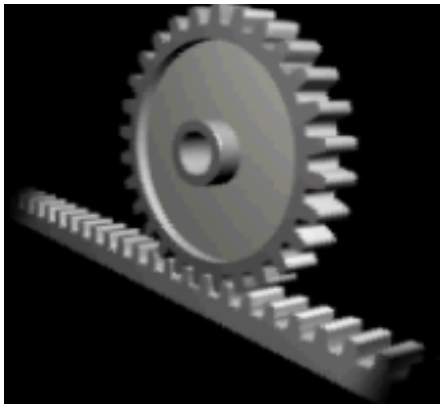
(N) Number of teeth

Theta : angular rotation



Rack & pinion gear:

Rack and pinion gears are used to convert the transitional motion to rotational motion



Calculation:

The calculation depend on :

S = 150 mm,

the distance that gear rotat (arc length).

Let N_1 (gear) = 40 teeth

Let N_2 (pinion) = 24 to 8 teeth

Equations that are used :

$$S = r_{1\theta}$$

$$d = 2r$$

$$P = \frac{N}{d}$$

Excel sheet

	A	B	C	D	E	F	G	H	I
1	theta	0.52	0.61	0.70	0.79	0.87	0.96	1.05	1.57
2	s	150	150	150	150	150	150	150	150
3	r1	287	246	215	191	172	156	143	96
4	N1	40	40	40	40	40	40	40	40
5	d1	573	491	430	382	344	313	287	191
6	p	0.07	0.08	0.09	0.10	0.12	0.13	0.14	0.21
7	N2	24	22	20	16	14	12	10	8
8	d2	344	270	215	153	120	94	72	38
9	r2	172	135	107	76	60	47	36	19

r1 = 96 mm
N1 = 40 teeth
N2 = 8 teeth
r2 = 19mm

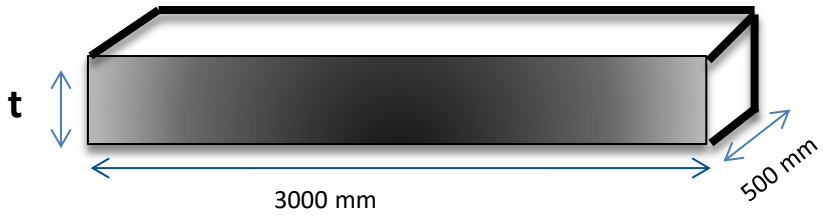
To check if r for gear 2 is true ?

If the arc length $\geq$ circumference for ger 2 , its true
S=150 mm

$$cirumference2 = 2\Pi r_2 = 2 * \Pi * 19.10828 = 120mm \langle S = 150mm$$

calculation for plate thickness

We will find the thickness of plate depend on



Material of plate : steel – 4140

Tensile strength = 1770 Mpa

Yield strength = 1640 Mpa

Length of plate = 300 mm

Width of plate = 500 m

Factor of safety (n) = 2

Thickness (t)

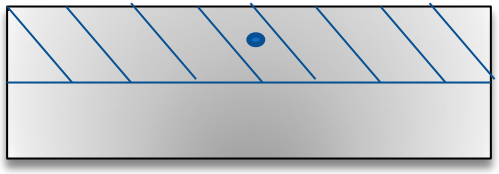
$$\tau_{\max} = \frac{VQ}{It} \longrightarrow Q = \bar{Y}\bar{A} \longrightarrow \bar{A} = 500 * \frac{t}{2} mm^2 \longrightarrow \bar{Y} = \frac{t}{4} mm$$

V=9810 N
M= 4905 N/mm
(from shear-moment diagram)

$$\tau_{\max} = \frac{14715}{t^2} n \le 1640 = \tau_{faluir}$$

t = 4.25 mm

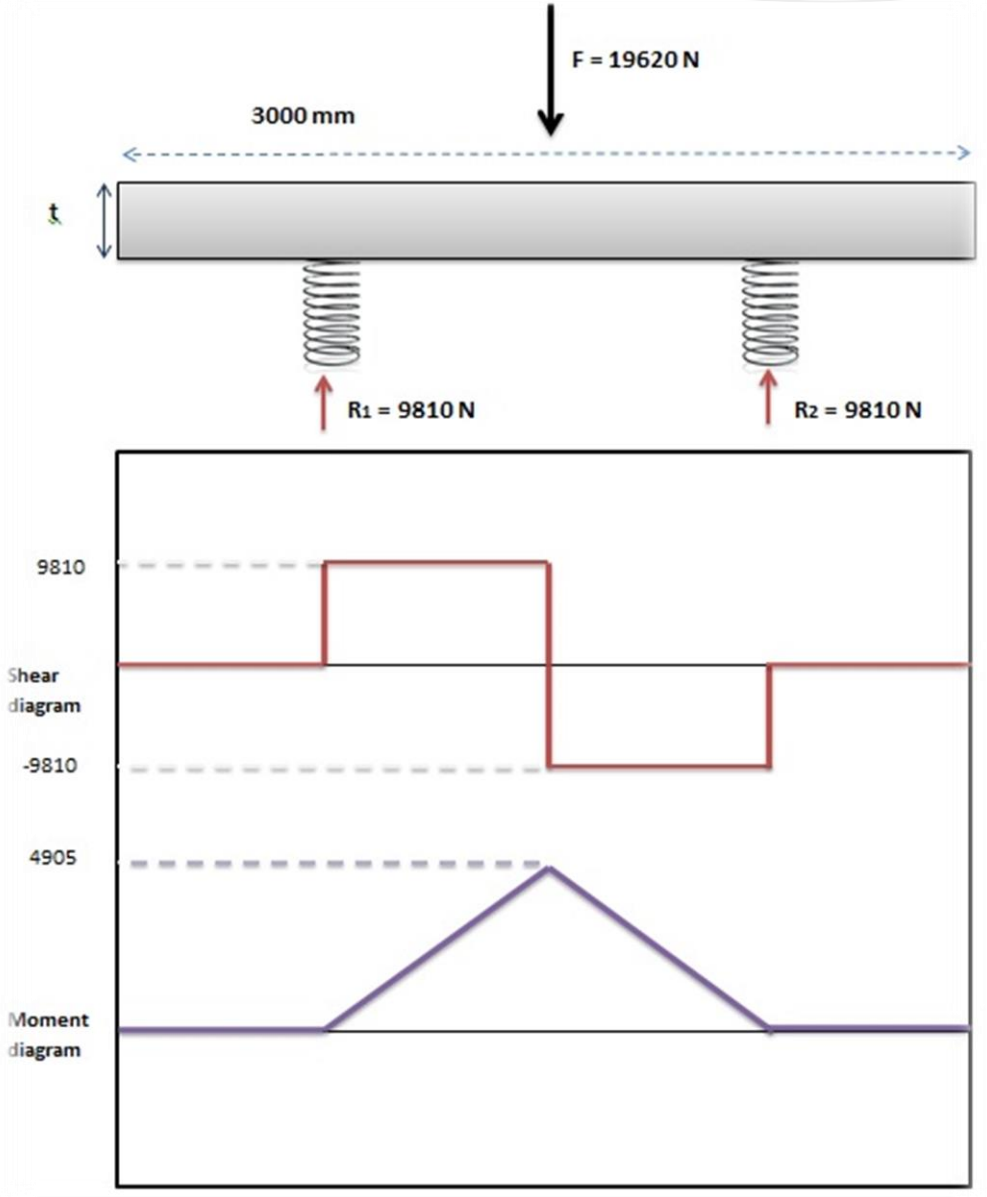
$$\sigma \max = \frac{MC}{I} \quad \text{where} \quad C = \frac{t}{2} \longrightarrow I = \frac{1}{12} bh^3$$



$$\sigma \max = \frac{58.86}{t^2} n \le 1770 = \sigma_{faluir}$$

t = .25mm

We will choose the largest thickness >>>
t=4mm


F = 19620 N
3000 mm
t
R1 = 9810 N
R2 = 9810 N
9810
Shear diagram
-9810
4905
Moment diagram

calculate the amount of energy produced daily by generator

For every car passes over the speed breaker , the generator could generate up to 72 watts ,and as the car passes by two levels :by the front wheels and by the back wheels ,the generator will be able to generate up to 144 watt for every car . From previous transportation statistics , about 500 cars will pass over the speed breaker each day , so the amount of power generated each day is : 500*144 = 72000 watt/day

Recommendation and Conclusions

Conclusion

In our project , the main goal was to provide a new cheap and clean source of energy depends mainly on the moving cars weights , which means it is completely clean. The running cost of the project is zero , and the construction cost is low . so our project is economically feasible and environmental friendly .

Our project is "electricity generation using speed breaker" , it consist of :

1- 2 steel plates
2- 2 helical compression
3- 3 gears (rack , gear and pinion)
4- 4 angular joints
5- rubber speed breaker
6- 2 rods
7- support guide block
8- bolts and welding

Recommendations

1. our project is very simple and upgradeable , so anyone can understand the working procedure and modify the project .

2. the speed breaker could generate more power by using more than one generator in the same speed breaker

3. the construction cost is low , the running cost is zero and its easy to maintain

4. you can put multiple speed breakers in the streets , which means generating and saving more power .

Thank you