



Finite Element Analysis to Predict Displacement and Velocity Distribution in Spring-Loaded Perpetual Motion Machine

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Abstract

Original Research Article

For more than four centuries, many inventors have suggested remarkable methods of getting energy from nothing thereby violating the 1st and 2nd laws of thermodynamics. This study designed, investigated and analyzed a spring-loaded perpetual motion machine. One dimensional governing equation for spring displacement was solved numerically using finite element (FE) method of solution and the power-out rating was calculated analytically. For displacement distribution in the spring length reveals how displacement is linearly distributed between 0 and 30m with length, ranging between 0 and 0.30m, using FE method; the obtained results revealed displacement distribution was linear, uniform and steady, which implied steady spring rate or displacement rate. Evaluated result showed that on applying a force of 27N on the flywheel, to set the machine in motion, generated a torque of 4Nm which is transmitted to the crankshaft. The resolved force from this torque is 100N with a corresponding 25Nm work output. This result shows that the machine is a PMM1, as the energy in is less than energy out continuously.

Keywords: PMM1, Finite element, Spring-loaded, Velocity, Displacement.

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INTRODUCTION

Perpetual motion machines of first kind are hypothetical machines that can run indefinitely without the input source of energy with output energy greater than the input energy. According to the 1st law of thermodynamics, energy cannot be created or destroyed but can only be transformed from one form into another.

According to Knill (2018), it would be nice to have a PM machine which would produce energy

from nothing. Where fuel will not be input material for work to be done! However, since there is no mathematical proof that such a machine cannot be designed and constructed then there is room for experimental trials. Especially when it is well accepted scientifically that all isolated physical process preserve energy and matter at a certain height possesses potential energy. Around 1715, Johann Bessler, presented a machine to be perpetual motion machine that operated for several period of time but did not. (Tsaousis, 2008). Tharaphe (2019) opined



that electricity can be seen everywhere to power electrical equipment without the need for fuels. And energies derived wind, solar, and so on are free energies.

Tharaphe (2019) worked on free energy system using the flywheel system. In the work, energy storing capacity of a flywheel was used to generate greater output free energy, which is used to run home appliances. The flywheel system consists of A.C. motor of 1½ hp used to power a series of belt and pulley with a resulting two times greater speed at the shaft of an alternator. Sundrabarathi et al. (2020) developed electricity generating perpetual motion. The PMM uses wheel to generate electrical energy from a generator to an AC motor via a control switch. In the experimental set up of the study, the motion of a perpetual wheel was transformed into electrical energy through the use of generator. The study was able to overcome challenges involved in electrical energy generation and low rating equipment. In Shubham (2018), neodymium magnets are arranged in an alternating N-S-N-S configuration on each component, enabling rotation through gravitational or magnetic force. An alternator is then used to convert the rotational motion into electrical energy, which is then multiplied by a transformer. On the other hand, Khan et al. (2014) system consisted of eight magnets positioned evenly around the edge of a circular disc, with a ring magnet located at the center of the former disc. The system was analyzed using theoretical calculations and simulation with PRO ENGINEER Wildfire 5.0 indicating that it is not a free energy system. Clinton and Rajkumar (2015) designed and fabricated a MOTO AUTOR, a replacement of conventional motor. The Moto Autor is capable of operating independently of fuel input, apart startup required fuel. It is a perpetual motion system that can energize itself by taking up the free energy present in the nature itself. This PMM enables systems to be motorized with minimal expenditure of energy. Mahesh & Madhavan (2021) study applied the concept of bicycle dynamo electricity generation by mean of gravitational force rather than the use of pedaling force. With this concept electricity can be generated to replace conventional fossil fuel lamps. Thomas et al. (2023) reviewed how a perpetual

motion machine that uses magnets can generate electrical energy.

STATEMENT OF THE PROBLEMS

There is increasing focus on the design and manufacture of PMM to operate machines and equipment in recent times. From the literature survey carried out, it was observed that a lot of studies, experiments and trials have been carried out on PMM and the result of which some equipment have been successfully powered like electric bulbs, electric drilling machine, portable electric grinding machines and so on. Consequently, it becomes imperative to study, design and evaluate a machine of this type if actually it is Perpetual Motion Machine of the 1st kind and that can generate electricity and/or possibly power a grater.

OBJECTIVES OF THE PROJECT

- (i) To design and construct spring-loaded PMM.
- (ii) To model and simulate the PMM-powered generator/grater.
- (iii) To evaluate and whether the constructed spring-loaded machine is a PMM 1.
- (iv) To ascertain whether machine is a PMM1 by comparing input energy and output energy.

METHODOLOGY

Design Considerations

In designing and constructing the spring-loaded perpetual motion machine, the following factors such as strength of materials, availability of materials and semi-finished, power requirement, maintainability of machine, ergonomics and reliability.

Design Specifications

In the designing of the study spring-loaded perpetual motion machine, certain design specifications were put into consideration such as

machine size, machine operating speed (rpm), the expected efficiency of machine, and the forces each rotating component.

Design Methodology

A spring-loaded perpetual motion machine is a machine which is made of springs arranged in series along a crankshaft which is mounted on bearings with a crankshaft attached at one end.

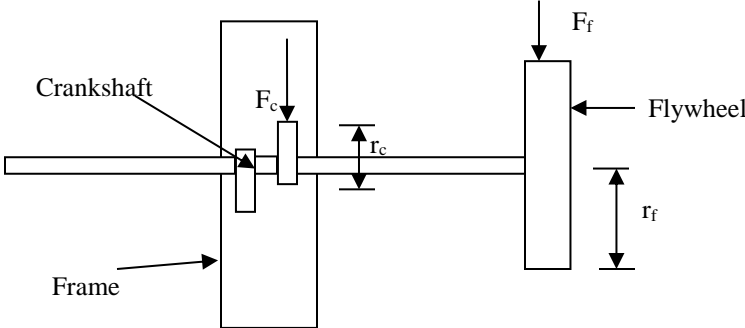


Fig 1: geometry of spring-loaded PMM

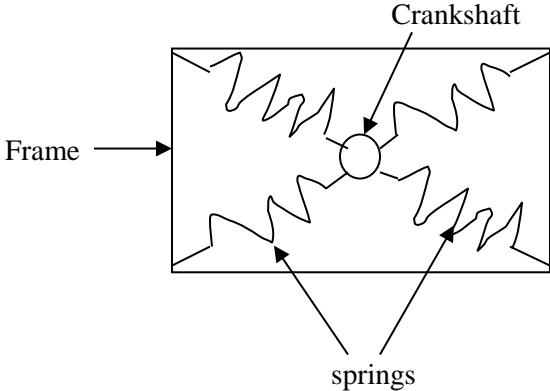


Fig 2: four springs connected to crankshaft and frame.

NUMERICAL ANALYSIS AND EVALUATION ANALYSES

Numerical modeling

Numerical modeling of the spring is carried out to show how the spring displacement varies along the length of the springs and then a simple approximate mathematical model is developed to

predict a one dimensional displacement distribution in the springs.

The formulation of spring finite element is as shown below.

In the analysis, 2 opposite springs are discretized into 2 elements with 3 nodes, as follows.

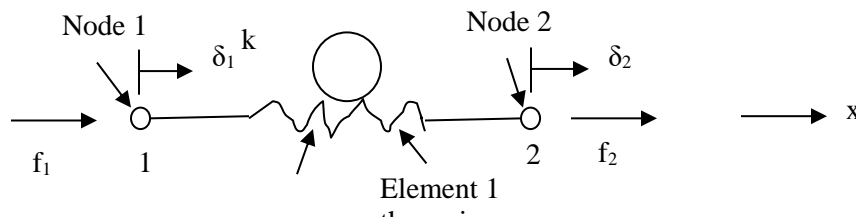


Fig 3: 1 element discretization

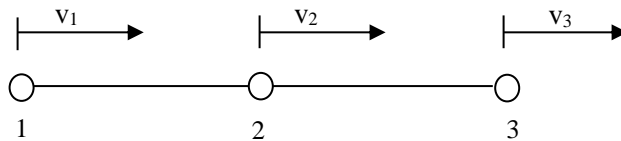


Fig.4: 2-element distribution at nodes

Note that if the displacement (δ) at any node in spring is known, then the total elongation or contraction of that spring will be the net force in the particular spring. At the nodes, the forces applied to the spring are denoted as f_1 and f_2 .

The spring displacement is calculated as,

$$\delta = u_2 - u_1 \tag{1}$$

Resultant force on spring is,

$$f = k(u_2 - u_1) \tag{2}$$

For equilibrium,

$$f_1 + f_2 = 0, \text{ i.e. } f_1 = - f_2 \tag{3}$$

From equation 2,

$$f_1 = -k(u_2 - u_1); \quad f_2 = k(u_2 - u_1)$$

A linear spring element will generate a 2 x 2 matrix, as shown in Fig. 4, with two nodal displacements (2 DOF) that are dependent.

Finite Element Formulation (Akpobi and Akele, 2019)

$$-k \frac{d}{dx} \left(\frac{du}{dx} \right) + F = 0 \quad 4$$

k is spring stiffness, u is displacement, F is applied force

Initial inlet and boundary conditions

Initial inlet and essential boundary conditions specified at the springs ends are:

$$u(0) = u_0 \quad u(L) = u_L \quad 5$$

Where u_i are the nodal values

Relevant assumptions

- Displacement distribution is steady.
- Displacement distribution is one dimensional, along x-axis only ($A \gg L$)
- Modulus of elasticity is constant (isotropic material).
- Element length is uniform over domain region.

FE method of solution

The derived one dimensional displacement distribution governing equation (4) was solved numerically using finite element method of solution; while the displacement distribution field, u, was modeled using displacement profile normal to the axis hence the two springs element domain was assumed to be 2 linear elements mesh along the x-axis. Where a typical element e will have interval of $h (= x_{i+1} - x_i)$ along x-axis. With the domain discretized into 2 elements mesh, then $h = (L - 0)/2$. Since displacement at node 1 and node 4 are specified

boundary conditions, the node 2 and node 3 finite element models are determined. The force on the spring is assumed to take place at point 3 in one dimension (1-D) elongation or contraction.

Displacement governing equation

$$k \frac{d^2 u}{dx^2} + F = 0 \quad 6$$

Subject to the following boundary conditions

$$u(0) = u_0; u(L) = u_L \quad 7$$

FE displacement solutions

$$u_1 = U_0 = 0; u_3 = U_L = 30; \quad u_2 = \frac{Fh^2}{2k} + \frac{1}{2}(U_0 + U_L) \quad 8$$

FE velocity solutions

$$v_1 = V_0 = 0; v_3 = V_L = 120 \frac{m}{s}; \quad v_2 = \frac{Fh^2}{2k} + \frac{1}{2}(V_0 + V_L) \quad 9$$

Exact solution is

$$u(x) = \frac{Fx}{2k}(L - x) + \frac{x}{L}(u_L - u_0) + u_0 \quad 10$$

Machine evaluation method of solution

Data at flywheel end:

Initial force F_f is applied to flywheel, $F_f = 27N$

Flywheel radius r_f is 0.15m

Torque T_f is generated at flywheel, $T_f = F_f \times r_f = 27N \times 0.15m = 4.05Nm$

Where,

F_f = force at flywheel

r_f = radius of flywheel

T_f = torque on flywheel

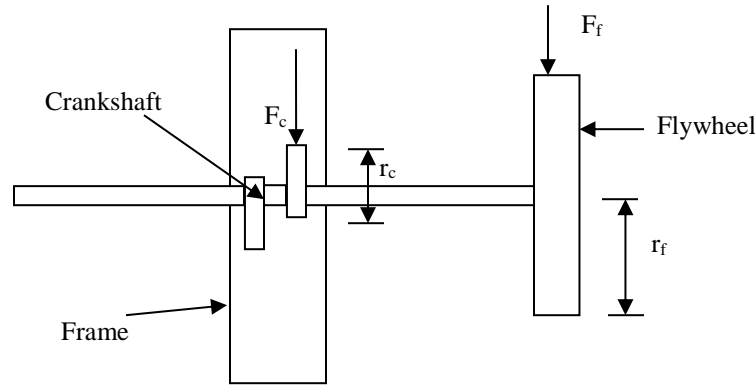


Fig.3: Schematic of spring-loaded PMM

Data at Crankshaft End: F_c is the force on one spring

torque at crankshaft $T_c = T_f$

crankshaft $r_c = 0.04\text{m}$

$F_c = T_f / r_c = 4\text{Nm} / 0.04\text{m} = 100\text{N}$

$V_c = 120\text{m/s}$; $r_c = 0.04\text{m}$

Work done $W = 2\pi \times r_c \times F_c = 25.13\text{Nm}$ per rev

$\omega_c = V_c / r_c = 120 / 0.04 = 3000\text{rev/s} = 2\pi \times 3000 = 18,849.6\text{rad/s}$

mechanical power $P_m = W_c \times \omega_c = 25\text{Nm} \times 18,850\text{rad/s} = 471.25\text{kNm/s} = 471\text{kW}$

electrical power $P_e = \text{volt (V)} \times \text{current (I)}$

But, $P_e = \eta_m P_m$

Assume an efficiency of 0.55, then,

$P_e = \eta_m P_m = 0.55 \times 471\text{kW} = 259.19\text{kW}$

Total electrical power P_e from 4 springs = $4 \times 259\text{kW} = 1036\text{kW}$

Where,

T_c = torque at crankshaft

r_c = crankshaft

F_c = force on crankshaft

V_c = linear velocity at crankshaft (determined by FE)

ω_c = angular velocity of crankshaft

P_m = mechanical power

P_e = electrical power

η_m = mechanical efficiency

RESULTS AND DISCUSSION

The results of the numerical analysis are presented in the following sections.

Table 1: spring displacement distribution at nodes

Nodal values h (m)	FE solution (FE) u (m)	Exact solution (ES) u (m)
0.00	0.00	0.00
0.05	5.75	6.25
0.10	11.50	12.00
0.15	17.25	17.25
0.20	21.50	22.00
0.25	25.75	26.25
0.30	30.00	30.00

Table 2: spring velocity distribution at nodes

Nodal values h (m)	FE solution (FE) v_i (m/s)	Exact solution (ES) v_i (m/s)
0.00	0.00	0.00
0.05	20.75	21.25
0.10	41.50	42.00
0.15	62.25	62.25
0.20	81.50	82.00
0.25	100.75	101.25
0.30	120.00	120.00

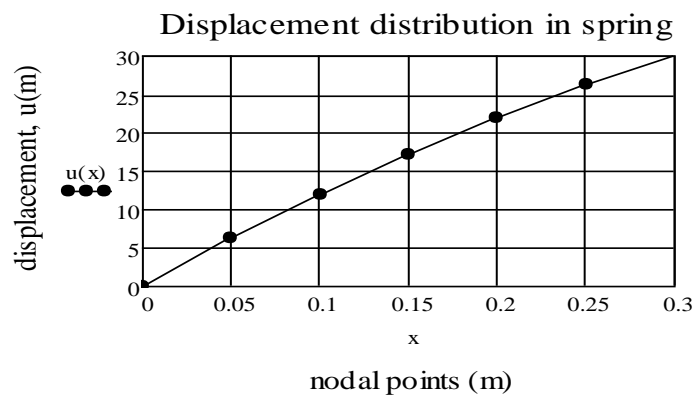


Fig. 4: displacement distribution in loaded spring

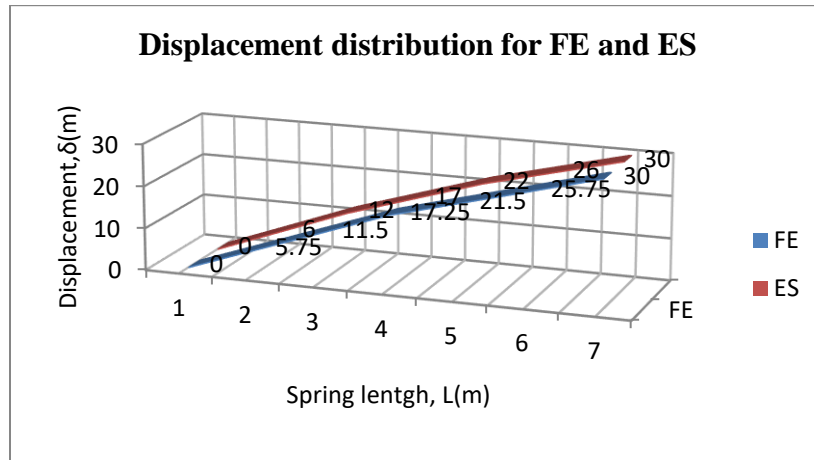


Fig. 5: comparison of exact and FE displacement distribution (3D view)

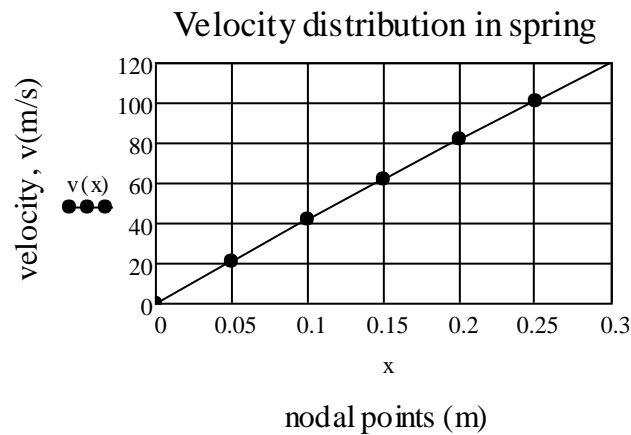


Fig. 6: velocity distribution in loaded spring

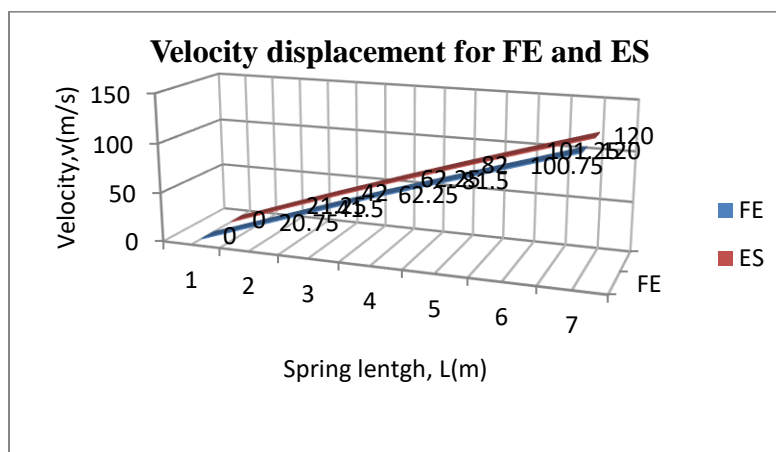


Fig. 7: comparison of exact and FE displacement distribution (3D view)

For 2 elements spring, Table 1 shows how FE (2E) displacement distribution increases from between 0 and 30m along element nodes (bold) and corresponding ES (2A). Table 1 shows, that two elements nodes values linearly approximated exact solution nodes values; while in Table 2 velocity is shown to increase from 0 to 120m/s along FE (2E) velocity distribution at element nodes (bold) and corresponding ES velocity (2A). This also implies that for 2 elements FE velocity nodal values linearly approximate with those of ES velocity solutions.

Both displacement and velocity distribution values are observed to increase with spring length (L) as load (F) increases. Fig.4 is a graph of displacement (m) against spring length (m), which reveals how displacement is linearly distributed between 0 and 30m with length, ranging between 0 and 0.30m; while Fig 5 is a 3D view of displacement distribution (m) against spring length (m) comparing FE solutions for 2 elements with ES solutions; Fig 5 reveals the linearity of FE method with approximate ES. Displacement distribution was linear, uniform and steady, which implied steady spring rate or displacement rate. Fig 6 is a graph of spring velocity (m/s) against spring length (m) showing how velocity is linearly distributed between 0 and 120m/s with length, ranging between 0 and 0.30m, using finite element method; while Fig 7 is a 3D view of velocity distribution (m/s) against spring length (m) comparing FE solutions for 2 elements with ES; Fig 7 reveals the linearity of FE method with approximate ES.

From evaluated result, it was observed that on applying a force of 60N on the flywheel, to set the machine in motion, generated a torque of 9Nm which is transmitted to the crankshaft. The resolved force from this torque is 225N with a corresponding 56.6Nm work output. This result shows that the device is a PMM1, as energy in is less than energy out continuously.

CONCLUSION

From the investigation and analysis, it is here concluded that:

- PMM-powered generator/grater was designed and constructed.
- Modeling and simulation of the PMM-powered generator/grater were carried out using FE analysis to ascertain distribution pattern of displacement and velocity in the springs. FE solutions were calculated and compared with derived analytical solution.
- PMM was study and evaluated and mechanical and electrical power-outs from the PMM were calculated using values and results obtained from FE analysis.
- It was ascertained that the machine is a PMM1 by comparing input energy with output energy.

RECOMMENDATIONS

There is need to use other methods of analysis to on this study PMM design to ascertain its reality.

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