STUDY AND FABRICATION OF REVOLVING DOOR FOR THE GENERATION OF ELECTRIC POWER

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***Abstract*— To meet energy demand, renewable energy and some unconventional source of energy can provide the necessary amount of clean energy for climate stabilization and reduce the consumption of fossil fuel. In this research, prospect and feasibility of power generation by using revolving door has been investigated. The objectives of this research project is to do the design and fabrication of prototype revolving door which can generate energy by amplifying the initial RPM of the door shaft. Gear, pinion and motor mechanism are used as an energy generation part of the proposed revolving door. Different data are taken by applying various conditions despite the RPM in practice. Modelling of different components of revolving door by is done by using CAD software Solidworks . After defining the material to be used, the mass and torque produced is evaluated while revolving action of door is taken as input power. A case study of a door installed in a commercial building is also presented for the prospects of its installation.**

***Keywords*— revolving door, energy, design, fabrication**

I. INTRODUCTION

Although in all fields of life we are surrounded by energy and the ability to harvest it and use it for constructive purpose as economically as possible is a challenge for mankind. The usage of traditional power generation method such as burning of coal, wood, diesel (for generator) etc. is continuously depleting our conventional resources, which is the demand for power has exceed the supply due to the rise in population. In additional to this the traditional methods cause pollution, encourage, deforestation (cutting of trees) the consequences are global warming, power shortage etc. Also, the sources are consumed at much faster rate than nature can produce them. Beside conventional energy sources, there exist many alternative renewable sources [1]. The renewable interest in the field of study comes from the effect of pollution both from burning fossil fuels and from nuclear waste byproducts. There are many means of harnessing energy which have less damaging impacts on our ecosystem.

Figure 1: Revolving Door [2]

The idea of power generation from revolving door leads to avail the electrical energy sources for various appliances. Door based power generation is specially

planned and fabricated for utilizing the available non-conventional energy sources. This machine converts mechanical force to electrical energy and the electricity charged through the door and can be stored in the battery. The door uses a generator that harvest the kinetic energy when the door spins and the super capacitor to store the energy. Power generation using revolving door can be effectively implemented in busy places like Malls, Parks, station, theaters, schools, and airports and so on. The method of generating electricity is not a major source but the low intensity operated devices can run for longer time. This concept takes place the world in the direction of non-conventional energy power generation and renewable energy. The stored power from this source into the batteries can be used in operating low intensity device.

Boon Edam developed a revolving door for the "Driebergen-Zeist" rail-way station in the Netherlands. That not only saves energy, but also generates energy with every person. The door developed by him uses a generator that harvests the kinetic energy when the door spins and a super capacitor to store the energy [3].

The main objective of this research work are:

- To fabricate a model of revolving door.
- To find an inexpensive solution for generation of electric power in a local community.
- To fabricate a scale down model of revolving door

There are some limitation while working on this research. The model is a scaled down version so can generate voltage only up to 12V only and the fabricated setup is 1/3rd of actual model so, average size person cannot pass through it.

II. METHODOLOGY

This research begins with the literature review, in which various books and research article published in this research area are studied. After this, conceptual design of the door is created. Based on this design various calculations are done to make a final design. After that material is selected for fabrication of the door. The door is fabricated in manufacturing lab at the university. Finally it is tested and various reading and measurement are taken for analysis.

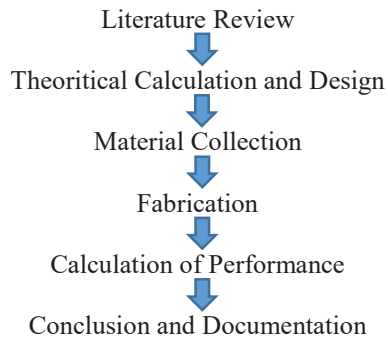

Figure 2: Methodology

III. DESIGN, FABRICATION AND TESTING

The theoretically determined dimensions of the setup is:

- Diameter of the door shaft = 34cm
- Length of door shaft = 130cm
- Diameter of the door panel =53cm
- Height of door panel = 119cm
- Gear box height = 35cm
- Gear box length = 60cm

In average, about 20 people enter in crowded mall per minute so, the RPM will be 10. A six gear compound gear train is connected at the bottom of the shaft whose specifications are:

Table 1 Gear Specification Table

Gear (name)	No of teeth	Gear teeth thickness (mm)	Pressure angle (degree)	Depth (mm)	Internal Diameter (mm)
1	18	2	60	18	30
0	18	2	60	25	25
0	18	2	60	25	25
0123	44	2	60	21	25
2	36	2	60	18	40
03	36	2	60	22	30

The gear ratio is calculated as

$$Gear\ ratio = \frac{(0123 \times 2 \times 03)}{(1 \times 0 \times 0)}$$

$$Gear\ ratio = \frac{(44 \times 36 \times 36)}{(18 \times 18 \times 18)}$$

$$= 10$$

The system will be thus connected to a power generation mechanism that will be a 12V 100rpm electro mechanical motor.

Mass of door panel with shaft (m) = 18 kg

No. of rotation per minute for door shaft=N1

No. of rotation per minute for generator=N2

Gear ratio= N1:N2=1:10

When we revolve the door it induce torque on shaft,

T=Force*Distance
=M*g*h
=18*9.81*(0.34+26.5)
=122.63Nm

Here, N1=10RPM N2=N1*8 =10*10

=100rpm

Rating of Generator Used:

Rated Voltage V=12V,

\N0=100RPM

Current capacity=0.7Amp

Internal generated voltage (EA)

EA/EA0=N/N0

Or, EA= (N*EA0)/N0

= (100*12)/100

= 12V

Armature current, IA=Load Ampere Hour (Ah)/60

=0.7/60

=0.01166A

Terminal voltage VT =EA-IARA

=12-0.01166*16

=11.81V

Output power = VT*IA

= 11.81*0.01166

=0.1377 Watt

The Model of the setup designed in SOLIDWORKS are as:

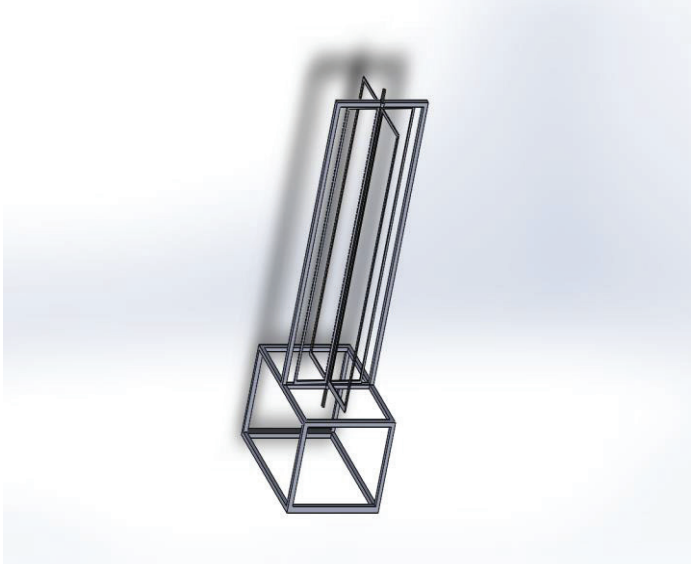

Figure 3: The Overall Setup

Materials Collection

Necessary materials were collected form locally available resources as well as from markets. The details are tabulated:

Table 2 Table for Material Selection

Materials	Purpose	Image
Metal rod	Metal rods were used for shaft (door shaft, Gear shaft)	 
DC motor	100 RPM dc motor was used to convert torque into power.	

Gears	Six spur gears having different teeth forms a gear mechanism that was used to increase torque.	
Bearings	4 bearings were used to freely rotate shafts	
Bulb	12V LED bulb was used for conformation of Electric power generation.	

Problems Encountered

Table 3 Table for Problems Encountered

S.N.	Terms	Problems	Solutions
1	Door panel	Initially the door was designed to have 3 panel with 120 degree rotation but was found to generate less torque.	It was replaced by 4 panel door with 180 degree rotation.
2	Gear and shaft connection	The connection between gear and shaft was found to be lose.	Mcell was used.
3	Design and Modification	Proposed design was found to be lacking support for the whole setup when utilizing the available materials rather than importing it from the market.	Design was subsequently modified to maintain the strength

1) 2.1.6 Final overview of Setup

Figure 4: Final Fabricated Model

The testing is performed and brake drum dynamometer setup is used to calculate the torque and rpm is calculated manually. It gives the power of 0.114 watt. So the efficiency of the system is found to be 83 %.

IV. RESULT AND DISCUSSION

The total power generated with one rotation of the door is found to be 0.114 watt. So for a complete rotation of the door there should be entrance of 4 person. We have taken a case study of a multinational shopping market i.e Walmart. According to the data provided from website of Walmart, every day 3500-4000 people shop in Walmart *[4]*. Let's us take 4000 people as the visitors. So, if this door is installed there. These visitors opens and closes the door. So each person makes a half turn of the door. So 4000 people will make 2000 turns. So the total power generated per day will be 228 watt. So the power generated per year will be 0.83 MW. But the real system will be three times bigger in size i.e roughly produce three times more energy. So it will generate roughly 2.5 MW of electricity.

V. CONCLUSION

The setup for generation of power from revolving door mechanism was fabricated as per the design. The setup consists of 4 door panel system. About 10 to 15 rpm was obtained from the setup and a 12V 100rpm motor is used to demonstrate the output via compound gear train mechanism. The total power generated with one

rotation of the door is found to be 0.114 watt. The case study of installation of this door on Walmart shows that it can produce roughly 2.5 megawatt of electricity.

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