Study and Feasibility Analysis for Power Generation by wind Belt System in Rural Areas of India

[a]Praveen Sisodiya, Assistant Professor, M.I.T., Ujjain India, praveen.mitujjain@gmail.com
[b]Abhinay Nigam, Assistant Professor, M.I.T., Ujjain India, nigamabhinay1706@gmail.com
[c]Arjun Panthi, Assistant Professor, M.I.T., Ujjain India, panthiarjun1@gmail.com

Abstract **As we realize that the power or electricity demand is continuously increased, so the power generation dependency is moved from nonrenewable to renewable sources. The rural and urban areas has now become increasingly dependent on renewable energy sources such as solar, wind, biogas etc. We chose to work on wind energy for this research paper in the rural areas. This paper investigates the efficiency of wind speed integrated with an aero-elastic-flutter based, energy harvester machine (Wind Belt). Flutter phenomenon has been used to change wind flow energy into electrical power through mechanical vibration. However, aero-elastic flutter initiates only when the wind speed is over a certain flutter commencement speed and the wind flow direction is nearly perpendicular to the flutter, which limits continuous power generation.**

Keywords —Energy harvesting Frame, aero-elastic Flutter, Wind energy, mechanical vibration, wind belt etc.

I. Introduction

In this framework we are paying attention on developing a Machine or product that can generate electricity using the kinetic energy of the wind. All the conservative wind mills have a simple phenomenon of doing the same. General machines which generate power/electricity with help of wind power known as wind mill has a rotating device called "turbine" which rotates when wind flows over it. The shaft is attached to a dynamo and thus electricity is generated. This procedure sounds pretty good. But, when we try to implement it on a small scale level, like lighting a LED or charging a mobile phone etc., there are lots of troubles involved. Rotation-based wind turbines don't balance down well due to friction and lesser energy of poorer wind speeds. So, there is a need to develop a new improvement or innovation which does not use rotary components, to achieve the mandatory targets at the small scale requirements.

II. Problem Statement and Objectives

A. Review Stage

Background study

Energy harvesting has been an energetic research area as demands for renewable energy sources increase. Energy harvesting systems refer to devices that capture and transform energy from the environment into electricity. Unlike conventional, large-scale renewable energy generating systems such as wind turbines, thermal generators, and solar panels, energy harvesting devices mostly target on powering small electronic devices.

The Wind belt is a wind power harvesting device invented by Shawn Frayn in 2004 for converting wind power to electricity. It consists of a flexible polymer ribbon stretched between supports transverse to the wind direction, with magnets glued to it. When the wind blows across it, the ribbon vibrates due to aero elastic flutter, similar to the action of an areolian harp. The vibrating movement of the magnets induces current in nearby pickup coils by electromagnetic induction. [1]

Shawn's Wind Belt: -

Now days a lot of research is being done to the efficiently harvest wind energy. Several designs for wind turbines have come up that improves the efficiency, but not to significant values. Aim of this shifts to develop a better use that can face the winds and effectively harvest wind energy. Effectiveness here stands for efficiency of the combined system in conjunction with the cost of the device. Shawn Frayne in 2007 developed a Wind Belt [2].

Shawn Frayne, an MIT graduate was the first person to discover this idea and he created something called "Wind belt". He started a company by the name "Humdinger" which sells these Wind belts. Inspired by him, we tried out working on the same principle in this course.

Reasons for recognition of need of wind belt

1. Wind power must still compete with conventional

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generation sources on a cost basis. Depending on how energetic a wind site is, the wind farm might not be cost competitive. Even though the cost of wind power has decreased dramatically in the past 10 Years, the technology requires a higher initial investment than fossil-fuelled generators.

2. Good wind sites are often located in remote locations, far from cities where the electricity Is needed. Transmission lines must be built to bring the electricity from the wind farm to the city. However, building just a few already-proposed transmission lines could significantly reduce the costs of expanding wind energy.

3. Wind resource development might not be the most profitable use of the land. Land suitable For wind-turbine installation must compete with alternative uses for the land, which might be more highly valued than electricity generation. [5]

B. Proposed solution of above reason

The purpose of this research project is to evaluate the relationship between aero-elastic flutter and an induced electric current to generating the electric power for small scale level, like lighting a LED or Charging a Smart phone etc.

Though conventional windmills produce relatively little power at low wind speeds, wind Belts can take advantage of the areas low average wind speeds. After doing a detailed Analysis of the above mentioned theories and specifications of wind & methods of its Harvesting in form of electricity, this solution is very commonly known as Wind Belt/Harvester.

C. Objectives

The detailed design of this project research is based upon a slightly different set of the objectives than its predecessors.

For this work, the ultimate goal was to be creating a prototype that could be easily replicated by almost anyone at a very low cost. Construction would be require the little building skill and would be consist of mostly recycled parts. Power & efficiency are not aim of this work; rather, it will be serve as a way for the people to learn about Wind belt design by getting hands-on experience by building one themselves.

The hope is that this model will help build a bigger base of people who are working to perfect the Win d belt design. Though larger the Wind belt prototypes can be daunting & expensive for average individual, the design of this specific Wind belt allows interested hobbyists to get their foot in the door and expand upon their original design later. Additionally, some new Belt materials will be tested as there are yet few feasible options. [2]

Advantages of a Wind belt

- It can also be used for lighting bed lamps.
- A Wind belt can be kept on a moving car and the output can be used to charge phone while travelling.
- A Wind belt can be placed on poles in high wind zones and used for street lighting.
- An array of Wind belts placed side by side can form a **"Wind cell"** and it may be used to light up an entire room!

III. METHODOLOGY

The Wind belt consists of a taut membrane of Camera Film roll, Neodymium magnets, Copper coil and a frame to hold these equipment. Apart from this, it consists electrical of Unit that gives the desired output power.

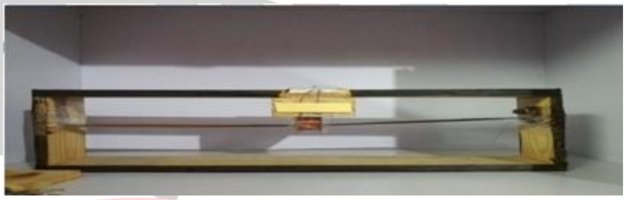

Figure 3:-Photograph of our Project

Analysis of Wind Belt:-

1. Dimensional Analysis

Table 1:- Dimensions of Model

SR. NO.	PARAMETERS	LENGTH (IN CM.)
1.	LENGTH	60
2.	HEIGHT	15
3.	TOTAL WIDTH	10
4.	BELT WIDTH	2.5

2. Analysis of Model

Analysis carried out under 3 specific conditions:

1. Carried out at Room Condition

2. Carried out under Blower/Cooler (Assuming Wind on Highways)

3. Carried out under Large Pedestal Fan of 2800 RPM (Assuming Wind in Coastal Areas)

IV. FEASIBILITY ANALYSIS

A. Analysis

a) When the width of tape is 2.5cm, we get 500mV voltage by using single coil and the position of magnet at that time is 50% of the total length of tape.

b) When the width of tape is 2.5cm, we get 700mV voltage by using two coils in series and the position of magnet at that time is 50% of the total length of tape.

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c) When we put the magnet at 25% of the total length of tape we get 600mV voltage by using single coil and the length of tape is same.

d) When we put the magnet at 25% of the total length of tape we get 300mV voltage by using two coils in parallel and the length of tape is same.

e) When we put the magnet at 25% of the total length of tape we get 1033mV voltage by using two coils in series and the length of tape is same.

f) When the width of the tape is 1.9cm, we get 127mV voltage by using two coils in series.

Table no. 4 (a) - For Single Coil Analysis For Belt Length, 1(m)

Sr. No.	Width(cm)	Voltage(mV)	Magnet Position (in %)
1	2.5	485	50
2	2.5	593	25

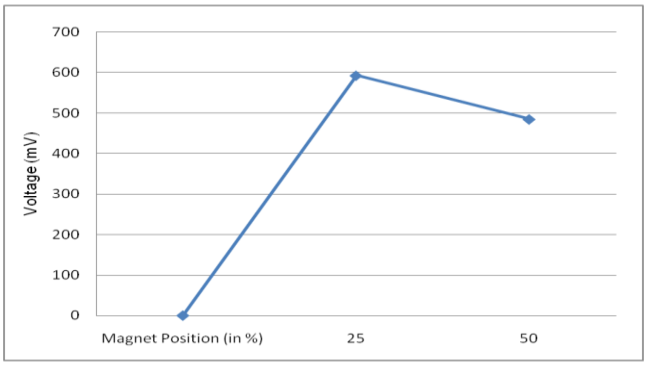

Fig 4 (a).Graph between voltage and magnet position of single coil for belt length, 1(m)

Figure describes the relationship between voltage and magnet position when we take a single coil and 2.5cm width. When magnet is placed 25% from right/left fixed end we get an output of 593mV and at 50% position we get an output of 485mV. Hence from which we describe that when we move from fixed end to 25% position our voltage is increasing and from 25%-50% our output voltage is decreasing.

Table no. 4 (b) - For Single Coil Analysis For Belt Length, 0.5(m)

Sr. No.	Width(cm)	Voltage(mV)	Magnet Position (in %)
1	2.5	292	50
2	2.5	341	25

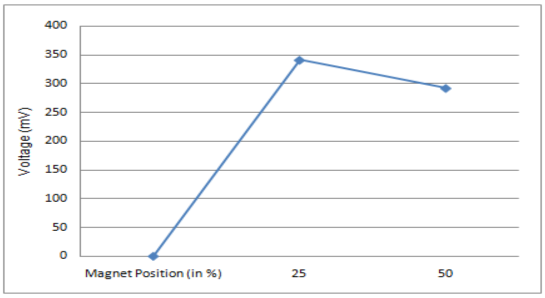

Fig 4 (b).Graph between voltage and magnet position of single coil for belt length, 0.5(m)

Figure describes the relationship between voltage and magnet position when we take a single coil and 2.5cm width. When magnet is placed 25% from right/left fixed end we get an output of 341mV and at 50% position we get an output of 292mV. Hence from which we describe that when we move from fixed end to 25% position our voltage is increasing and from 25%-50% our output voltage is decreasing.

Table no. 4 (c) - For Double Coil Analysis for Belt Length, 1(m)

Sr. No.	Width(cm)	Voltage(mV)	Magnet Position (in %)
1	2.5	695	50
2	2.5	1033	25
3	1.9	127	50

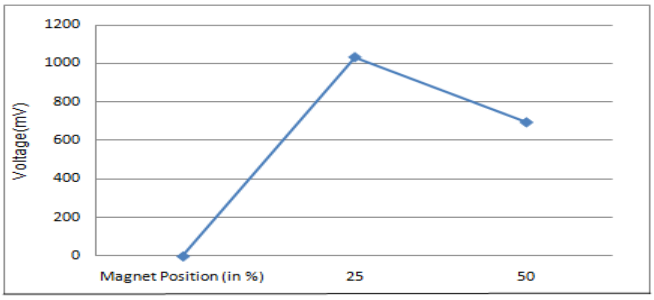

Fig 4(c). Graph between voltage and magnet position of double coil for belt length, 1(m)

Figure describes the relationship between voltage and magnet position when we take a double coil and 2.5cm width. When magnet is placed 25% from right/left fixed end we get an output of 1033mV and at 50% position we get an output of 695mV. Hence from which we describe that when we move from fixed end to 25% position our voltage is increasing and from 25%-50% our output voltage is decreasing.

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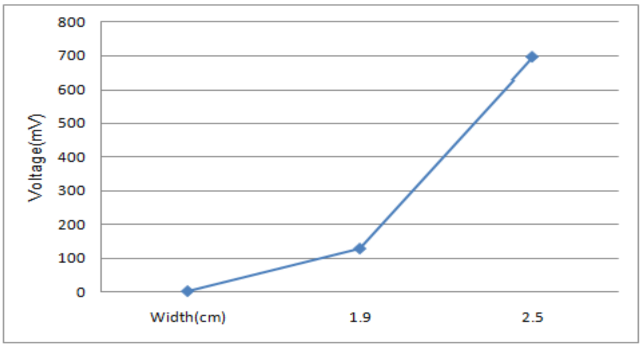

Fig 4.1(c). Graph between voltage and width of double coil for belt length, 1(m)

Figure describes the relationship between voltage and width when we take a double coil and placed magnet at 50% from the fixed end. When we take 1.9cm width we get an output of 127mV and at 2.5cm width we get an output of 695 mV. Hence from this we describe that when width is increasing voltage is also increasing i.e. width and voltage are proportional to each other.

Table no. 4(d) - For Double Coil Analysis For Belt Length, 0.5(m)

Sr. No.	Width(cm)	Voltage(mV)	Magnet Position (in %)
1	2.5	413	50
2	2.5	829	25
3	1.9	97	50

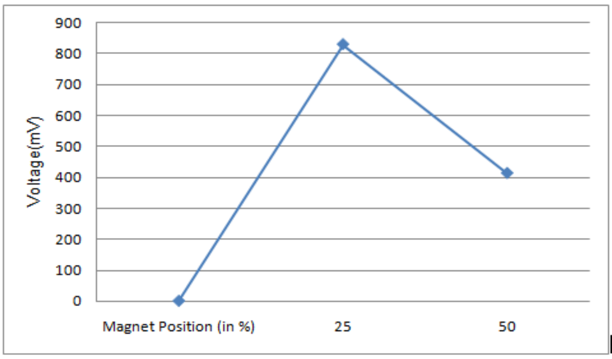

Fig 4(e). Graph between voltage and magnet position of double coil for belt length, 0.5(m)

Figure describes the relationship between voltage and magnet position when we take a double coil and 2.5cm width. When magnet is placed 25% from right/left fixed end we get an output of 829mV and at 50% position we get an output of 413mV. Hence from which we describe that when we move from fixed end to 25% position our voltage is increasing and from 25%-50% our output voltage is decreasing.

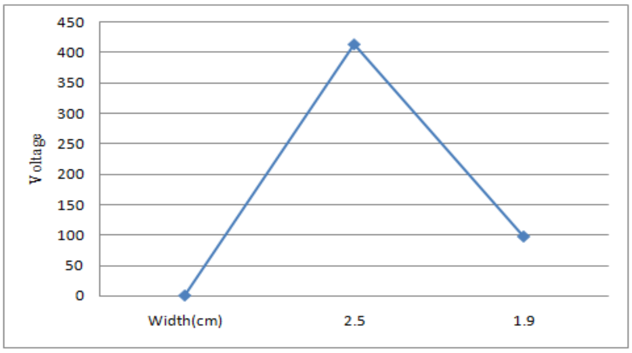

Fig 4 (f). Graph between voltage and width of double coil for belt length, 0.5(m)

Figure describes the relationship between voltage and width when we take a double coil and placed magnet at 50% from the fixed end. When we take 1.9cm width we get an output of 97mV and at 2.5cm width we get an output of 413 mV. Hence from this we describe that when width is increasing voltage is also increasing i.e. width and voltage are proportional to each other.Capitalize only the first word in a paper title, except for

V. CONCLUSION

The project Windbelt is easy and quite interesting that helps to convey the concept of aeroelastic flutter, but is not practical for power production. Windbelt technology is still in its infancy and needs a broader base of researchers building and testing a number of different variables that affect Windbelt power output. Currently, prototypes are being built and tested by many different groups of students but as of yet there is no open-source data for precise design.

By making prototype of 1 meter Windbelt length we get unstable output of 1.99 volt by which we light an LED.

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