Fabrication and Analysis of Vertical Axis Wind Turbine on Highways

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Abstract: Wind energy is one of the non-regular types of energy and it is accessible in wealth. Power can be created with the assistance of vertical hub wind turbine. This task points of using this breeze energy in best way to get the most extreme electric yield, and along these lines we chose thruway as our establishment site where we can exploit the moving vehicles on both the sides of the street. In the present work, turbine is plan and manufactured according to the determinations, the sharp edges utilized are semi-round shape and are associated with the plate which is associated with shaft. Shaft is then combined with pulley with the assistance of bearing, and afterward pulley is associated with the alternator, which creates the power. The power created is put away in battery and after that can be utilized for road light, sign or toll. In this task a little model has been made for testing reason. This task additionally goes for most extreme yield with least expense. The geometrical model is created utilizing CATIAv5 and imported to ANSYS18.0 for examination. Familiar examination is performed by change of wind speeds. Vibration analysis is done to check the safety against resonance.

Keywords: VAWT, Design, Fabrication, CATIAv5, ANSYS18.0

1. INTRODUCTION

Wind power is the utilization of wind current through wind turbines to give the mechanical capacity to turn electric generators. Wind control, as an option in contrast to consuming petroleum derivatives, is copious, sustainable, broadly circulated, clean, delivers no ozone harming substance emanations during activity, devours no water, and uses little land. The net impacts on the earth are far less hazardous than those of non-renewable energy source sources.

Wind homesteads comprise of numerous individual breeze turbines, which are associated with the electric power transmission arrange. Coastal breeze is a reasonable wellspring of electric power, focused with or in numerous spots less expensive than coal or gas plants. Seaward wind is steadier and more grounded than ashore and seaward ranches have less visual effect, however development and upkeep expenses are extensively higher. Little inland wind ranches can encourage some vitality into the framework or give electric capacity to detached off-network areas.

Wind power gives variable power, which is steady from year to year however has critical variety over shorter time scales. It is along these lines utilized related to other electric power sources to give a dependable supply. As the extent of wind control in a locale expands, a need to overhaul the framework and a brought capacity down to displace traditional generation can occur. Power-the board strategies, for example, having abundance limit, topographically conveyed turbines, dispatch capable sources, adequate hydroelectric power, sending out and bringing in capacity to neighbouring territories, vitality stockpiling, or lessening request when wind creation is low, can much of the time beat these issues. Climate gauging grants the electric-control system to be prepared for the anticipated varieties underway that happen.

In 2018, worldwide breeze control limit extended 9.6% to 591 GW. In 2017, yearly wind vitality creation developed 17% achieving 4.4% of overall electric power use, and giving 11.6% of the power in the European Union. Denmark is the nation with the most elevated entrance of wind control, with 43.4% of its devoured power from wind in 2017. In any event 83 different nations around the globe are utilizing wind capacity to supply their electric power lattices

2. Design and Fabrication

2.1. Problem Description

Presently a days the prerequisite of the intensity of the greatest issues. As there is dependably deficiency in the power provided there is more interest for the ability to be generated. India as a creating nation there is more interest for the power for industries, irrigation and numerous reasons.

As wind is an inexhaustible and modest and effectively accessible in nature we need to use in productive manner. Highways are the one of best wellsprings of wind vitality which are brought about by the ceaseless development of the vehicle which cause fast breezes.

Our zone of intrigue is to catch this fast breezes to produce control by utilizing the correct breeze turbine which can almost certainly catch wind every which way in proficient and shoddy way. This can be accomplished by utilizing distinctive kind of reasonable materials and legitimate structure.

The primary aphorism of this undertaking to catch wind brought about by vehicle development and use it in effective way for road bulbs and putting away power in batteries and for sign lights.

2.2 Design of Components

The cutting edge is structured fit as a fiddle so as one sharp edge passes another edge comes in the situation of first. 8 sharp edges are utilized in order to utilization of most extreme

Use of wind from air and moving vehicle.

A= d*h

d= diameter of the blade (cm)
h=height of the blades (cm)

So area = (78*7.62)
= 594.36 sq.cm

This height and diameter is chosen due to Restriction of use of more rotor diameter due to Available of less space to install on highway.

Fig 2.1. Fabricated blades from PVC pipes

2.2.1 Supporting Shaft

While structuring the pole it ought to be appropriately fitted to focuses of the pulley. The pole has width of 1inch to effortlessly fix in the circle and at the top and base closures mellow steel plates are connected of Thickness 2mm.

Fig 2.2 Supporting shaft at the hub

2.2.2 Supporting mild steel plates

These are used for the supporting between shaft and pulley, and between pulley and stand .this can be achieved by welding. The thickness of the plate is 2mm of diameter 1inch.

Fig 2.3. Supporting mild steel plates

2.2.3. Supporting Stand:

The stand is made up of MS material and square in shape in order to support the whole body of the turbine. The dimensions of the stand are 1/2ft height, 1ft length and 1ft width.

Fig 2.4 Supporting stand

2.2.4. Selection of pulley

There are 2 pulley used one big pulley and one short. Big pulley is attached to the shaft and lower pulley is attached to the dimmer dynamo. Big pulley is made up of MS so as to decrease its weight so it can rotate freely. Both the pulley are attached with the help of a belt. This pulley increases the rotational speed of the turbine. Diameter of big pulley: 78cm Diameter of small pulley: 2.5 cm

Fig 2.5 Bigger pulley

Fig 2.6 Smaller pulley

3. Methodology

Theoretical Calculations are made to calculate the power output. The kinetic energy of the wind is converted into power out due to impact of the wind jet. The power output is calculated for different wind velocities. The calculations are made using the below formulae. The winds speeds are taken in the range of 4 m/s to 10 m/s. The experimental calculations are done in the same range of wind speeds. The average wind speeds obtained from the highways are taken for different speeds of vehicles and the range is chosen from them. The experimental setup is as shown below. The blower with speed regulator is taken, anemometer is used to check speeds of wind speeds. Voltmeter and ammeter are connected to record the voltage and current generated.

Fig 3.1. Experimental Methodology

Kinetic Energy available:

K E = ½ ρ AV^3

ρ = density of air (1.225 kg/m3)

Available wind power

P = 1/8 ρ π D^2V^3

Diameter of Blade=.072m

3.1 Experimental calculations

Power =voltage*current

Table 3.1 Theoretical Results for various wind speeds

Wind speed(m/s)	Power(W)
4	3.34
5	5.58
6	9
6.5	10.5
7	14
7.5	16.2
8	19
8.5	23.2
9	26.5
9.5	33.4
10	39.65

This table shows the data which are available wind speeds and energy present in it for our model which is designed. As highway is one of the source of continuous wind movement we can be able to capture wind to run the turbine. This is mainly done by vertical axis wind turbine as it is installation cost is less and area required for implementation is also less. And it can be able to capture wind in all directions. The main energy present in wind is kinetic energy which can be converted into power by using the above expression.

Table 3.2 Experimental results for various wind speeds:

Wind speed(m/s)	Current(amps)	voltage(volts)	Power(W)
4	0.5	3.76	1.88
5	0.7	3.86	3.2
6	1.2	4.33	5.26
6.5	1.1	5.39	5.93
7	1.22	6.43	7.85
7.5	1.25	7.44	9.3
8	1.27	9.6	12.2
8.5	1.3	11.3	14.7
9	1.32	13.38	17.66

In this table of results we can change over the active vitality of wind into electrical power successfully by utilizing savonious wind turbine which is utilized to catch wind from all bearings at various breeze speeds as appeared. We realize that the power is a result of voltage and current. This is determined by setting a multimeter to quantify the voltage and the current and anemometer to gauge the breeze speed.

3.2 Calculation of Natural Frequencies:

The replica of the VAWT is modelled in CATIA as shown in the figure. The model is imported into ANSYS to perform vibration analysis. The material is added to the product the vibration is analysed by giving boundary conditions. Six modes of natural frequencies are found out from ANSYS.

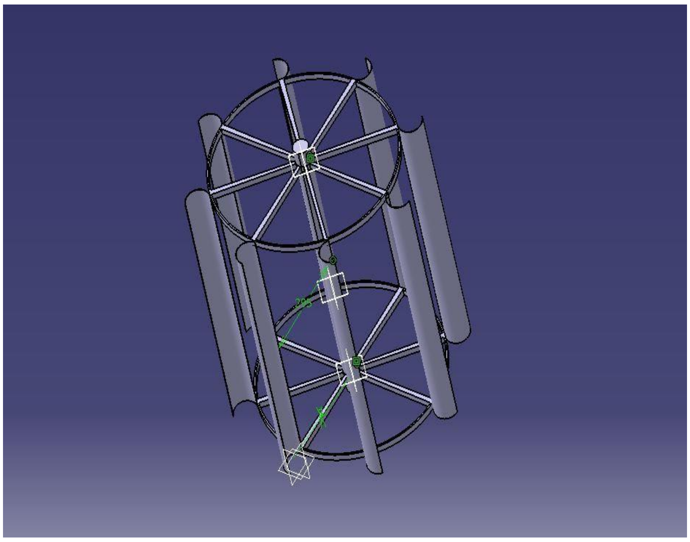

Fig 3.2. Final product modelled in CATIA

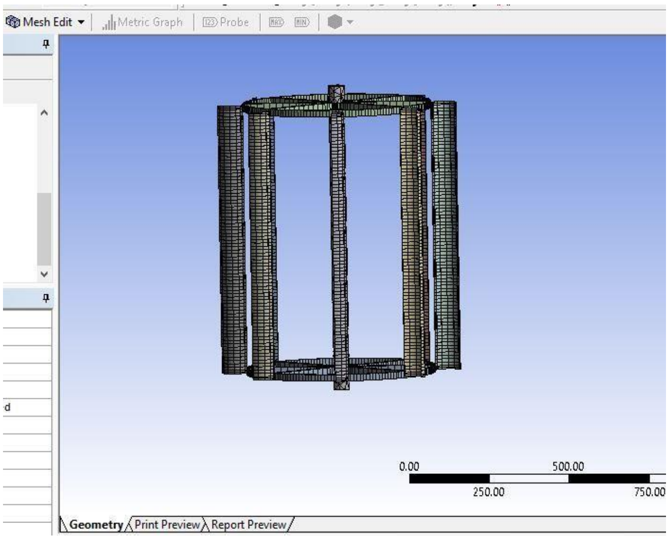

Fig 3.3. Meshed model in ANSYS

4. Results and Discussion

The VAWT is structured and created so that the it can ready to catch wind from all the heading, control created from the task is 9.7watts for a speed of 7.5m/s, the productivity of VAWT can be increment by changing the size and state of the edge, the hypothetical and exploratory outcome is fluctuating on the grounds that in hypothetical computation we consider the breeze is hitting all the eight turbine cutting edges, for all intents and purposes it isn't. The work and the outcomes got are supported that vertical hub wind vitality change are conceivable and possibly very add to the creation of the clean inexhaustible power from the breeze even under low perfect sitting conditions. With the thought on parkway, it self-discipline up road lights. In many urban communities, roadways are a quicker course for every day drive and needing steady light makes this an exceptionally proficient approach to deliver common vitality.

Table 4.1 Comparison of Experimental and Theoretical results

	Experimental	**Theoretical**
Wind speed(m/s)	**Power(Watts)**	**Power(Watts)**
4	1.88	3.34
5	3.2	5.58
6	5.26	9
6.5	5.93	10.5
7	7.85	14
7.5	9.3	16.2
8	12.2	19
8.5	14.7	23.2
9	17.66	26.5

4.1 Graph between wind speed v_s voltage, power and current

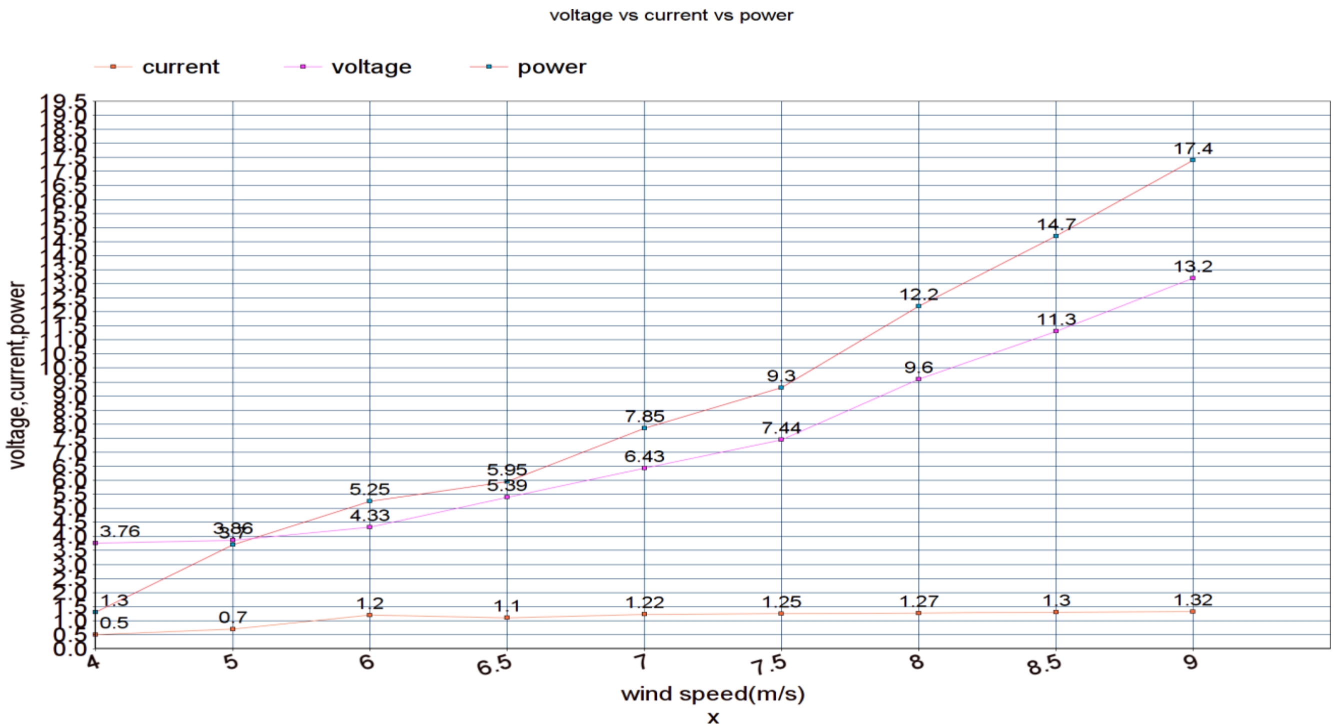

Fig 4.1. Graph between wind speed v_s voltage, power and current

4.1.1. Discussion

In this graph it shows the relationship between the voltage, current and power. In the above graph it is clear that the how the power is varying with the respective to wind speeds. As the wind speed is increasing there is quick change in the power which is the product of voltage and current. Variation in current takes place when the load on the turbine increases. Generally low speeds are not favourable for the power generation, Highways are the selected for the power for the power generation as there are abundant amount of wind available due to the continuous movement of the vehicle which will generate high wind speeds

4.2. Graph between actual power and available power

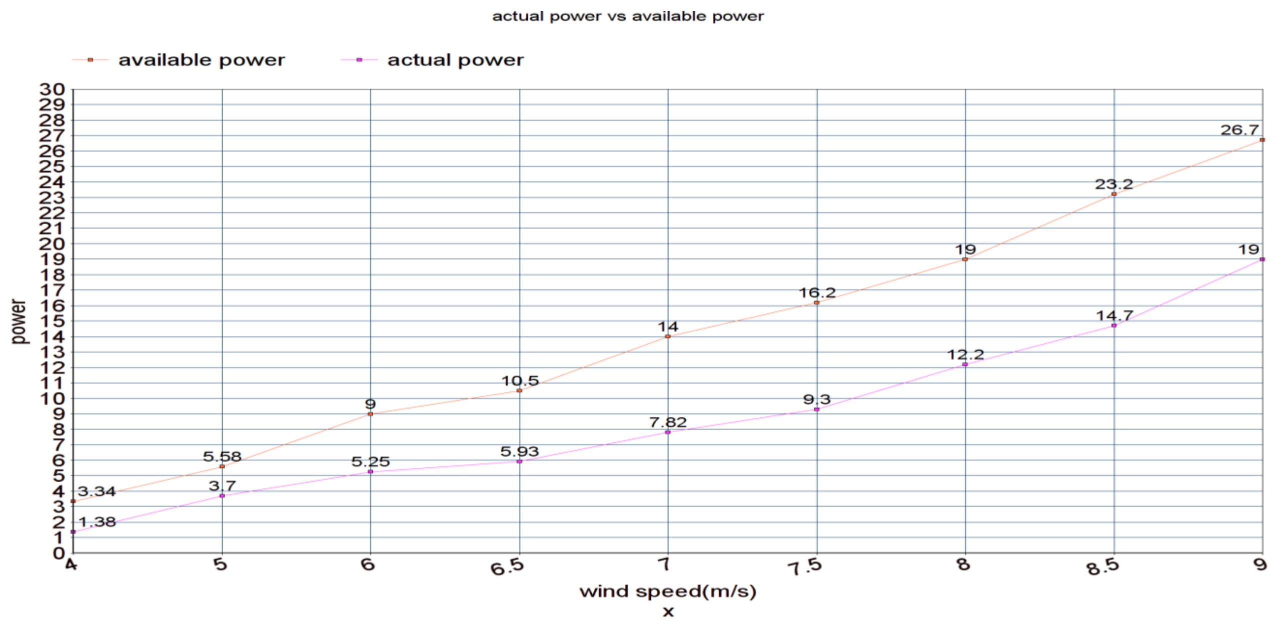

Fig.4.2. Graph between actual power and available power

4.2.1. Discussion:

This graph gives the clear view of power variation between the theoretical and experimental values. The main reason for this is if wind turbine have to covert wind speed to 100% of energy available in the wind which leaving after hitting the wind turbine should be zero which is impossible. We can improve the power output by further modifying the blades cross section and materials used for it. This is the main reason for the variation in the power outputs of theoretical & experimental

4.3. Natural Frequency results

Tabular Data

	Mode	Frequency [Hz]
1	1.	29.515
2	2.	29.553
3	3.	53.53
4	4.	75.437
5	5.	118.43
6	6.	119.87

Fig.4.3. Six modes of natural frequencies

4.3.1 Discussion

The running frequency of the wind turbine is in the range of 0 to 400 rpm. The maximum running frequency of the wind turbine is 6.6 Hz. The mode1 natural frequency obtained from the ANSYS modal analysis is 29.5 Hz. There is a large difference between the running and natural frequencies avoiding the chance of resonance. Hence, the design is free from vibrations and safe

5. Conclusions

The VAWT is designed and fabricated in such a way that the it can able to capture wind from all the direction, power developed from the project is 9.7watts for a speed of 7.5m/s, the efficiency of VAWT can be increase by changing the size and shape of the blade, the theoretical and experimental result is varying because in theoretical calculation we consider the wind is hitting all the eight turbine blades, practically it is not. The work and the results obtained are very encouraged that vertical axis wind energy conversion are plausible and potentially very contribute to the production of the clean renewable electricity from the wind even under low ideal sitting conditions. With the idea on highway, it will power up street lights. In most cities, highways are a faster route for daily commute and in need of constant light makes this a very efficient way to produce natural energy.

6. References

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