A Review on: A Design of Traffic Powered Wind Turbine

Mahesh Mittha[1] Prathamesh Malvankar[2] Amruta Dange[3] Omkar Padwal[4] Reshma Patil[5]
[1,2,3,4]Student [5]Assistant Professor
[1,2,3,4,5]Alard College of Engineering & Management, Pune, Maharashtra, India

Abstract— The objective of the project is to design a wind turbine to recapture wind energy from vehicles on the highway. Wind energy is considered the fastest growing clean energy source however; it is limited by variable natural wind. Highways can provide a considerable amount of wind to drive a turbine due to high vehicle traffic. This energy is unused. Extensive research on wind patterns is required to determine the average velocity of the wind created by oncoming vehicles. The wind turbines will be placed on the medians therefore fluid flow from both sides of the highway will be considered in the design. Using all of the collected data, existing streetlights on the medians can be fitted with these wind turbines. Additionally, since the wind source will fluctuate, a storage system for the power generated will be designed to distribute and maintain a constant source of power. Ideally, the turbine can be used globally as an unlimited power source for streetlights and other public amenities.

Keywords: Traffic Powered Wind Turbine

I. INTRODUCTION

The world is becoming increasingly advanced in technology, manufacturing and agriculture to fulfill the demands of human beings as the population increases. These advancements were mostly accomplished through manipulation of non-renewable energy sources such as petrol and water for daily life purposes of operating factories, vehicles, electrical fuel, however, millions of years are required for them to be restored. Furthermore, fuels pollute the environment, cause global warming and numerous diseases. As a substitute for these types of energy sources, alternative energy generators must be used by means of manipulating wind for energy production. Wind turbines are extremely qualified due to their environmentally friendly characteristics and more importantly, their high efficiency and energy generation capability. Wind is highly competent to replace fossil fuel when it comes to electricity production following its conversion to mechanical energy. . It is abundant and does not pollute the environment since there is neither chemical reaction nor emissions nor combustion. Wind energy has been used for thousands of years in many parts of the world. In 11th century, Europe and Middle East, people utilized it in moving boats and in operating agricultural.

Windmills, wood cutting and in pumping water. In 1970’s United States, the shortage of oil stimulated the development of the idea of utilizing wind as an alternative energy source and as a result, wind turbines have been produced thereafter it slowly spread out in the world. [1] This conversion is performed using wind turbines. The primary types of turbines are Vertical Axis Wind Turbine (VAWT) and Horizontal Axis Wind Turbine (HAWT). Horizontal Axis Turbines contains both downwind and upwind configurations. HAWTs operate only in high-speed wind and are more efficient than VAWT but rendered ineffective during turbulent winds. Vertical Axis Turbines are smaller in size and operate in low-speed wind; their blades are designed in a manner that is able to rotate in any direction and type of wind, whether turbulent or laminar. VAWTs can be installed in urban areas due to their small size, relatively quiet and safe characteristics, being easy-to-install and cheapness in terms of repairs and maintenance. However, HAWTs are only placed in rural areas where there are no inhabitants due to their massive size and their need for high speed wind to operate. There are two types of VAWT, drag type and lift type. The drag type has high torque but law rotational speed which can be used for water pumping applications. However, the lift type has low torque but high rotating speed which can be used for producing high electrical power.

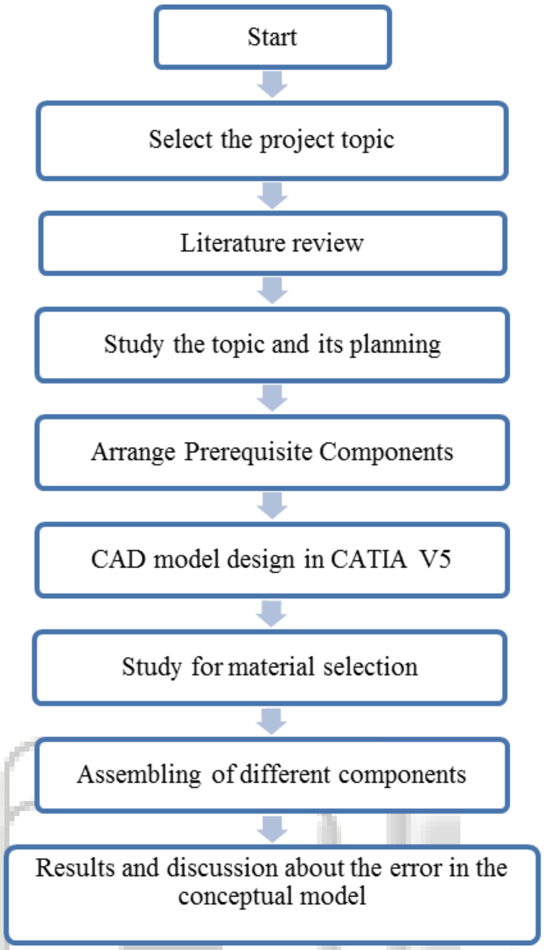
II. PROBLEM DEFINITION

Each year, in the world, several trillion kWh are expended on street lighting. A high consumption means a high amount of generated energy, which in turn translates into a high level of noxious emissions. Secondly, there are difficulties related to the maintenance of the system. the problem related to the billing of the street lighting energy consumption,

III. OBJECTIVES

1) The main objective of this project is to utilize the maximum amount of wind energy from the automobiles running on the highways.
2) The unused and considerable amount of wind is used to drive the vertical axis wind turbine, which will use the kinetic energy of the wind to produce the electrical energy.
3) To overcome the maintenance cost incorporated in traditional lighting systems.

IV. METHODOLOGY



V. LITERATURE REVIEW

[1] Muhammad Mahmood Aslam BhuttaNasir HayatAhmed Uzair Farooq Zahid Hussain (2012) Increased concern for environment has led to the search for more environment friendly sources of energy. Wind energy can be a viable option in this regard. Vertical axis wind turbines offer promising solution for areas away from the integrated grid systems.

[2] J. VigneshA. Simon ChristopherT. AlbertJ. Sunil(2019) It is well known that the nonrenewable resources such as fossil fuels, oils, natural gas, etc. which will certainly get exhausted sooner or later. Among the various non-convention methods for generation of electric power, wind has found its place to be efficient.

[3] Anil Dhanola H.C Garg(2020) The power generation from wind farms is growing very fast all over the world, and wind energy is now playing the most significant role to aid sustainable development since the last decade. The recent studies on the development of the new design of bearings, improvement in surface engineering of bearings, use of advanced lubrication for the gearbox, and continually monitoring the conditions for early fault detection of bearings have been incorporated in the paper

[4] Brian Handrew Cashman(2020) This paper discusses the historical evolution of the lift-type vertical axis wind turbine (VAWT) since its inception in the early 1930s. The VAWT received almost no development until the early 1970s when engineers in Canada and the USA began to study the VAWT design as a source of generating electricity.

[5] Kalakanda Alfred SunnyNallapaneni Manoj Kumar(2020) This paper presents aerodynamic modelling, fabrication and the performance evaluation of vertical axis wind turbine (VAWT). Aerodynamic modelling of VAWT is designed using software tools by considering NACA0012 airfoil whose chord length is 0.12 m. Aluminum material based light weight 3 bladed practical prototype model of VAWT having rotor diameter and rotor height as 0.36 m and 0.40 m respectively is fabricated. This practical prototype model is tested in subsonic wind tunnel to analyze the performance parameters like power in the wind, mechanical power at turbine shaft, tip speed ratio (TSR) and power coefficient. The rotor is tested under different wind speeds ranging from 4.38 m/s to 22.38 m/s, test results shows the reliable and efficient performance

[6] Seralathan SivamaniMukesh NadarajanR. KameshwaranV. Hariram(2016) Most of the scholarly focus to date has been on large horizontal axis rather than vertical axis wind turbines. It may be possible to improve the efficiency of vertical axis wind technology by deploying turbines in clusters. There might also be advantages to deploying vertical axis turbines at a smaller scale in urban or suburban areas and in places where the risk of bird damage is highest. Would these features increase public acceptance of new wind turbine installations and possibly open up new areas for wind energy development

[7] Kalakanda Alfred SunnyNallapaneni Manoj Kumar(2017)A wind turbine blade generally has complex structures including several layers of composite materials with shear webs, making its structure design very challenging. In this paper, a structural optimisation model for wind turbine composite blades has been developed based on a parametric FEA (finite element analysis) model and a GA (genetic algorithm) model.

VI. CALCULATION

A. Power Calculations

The wind turbine works on the principle of converting kinetic energy of the wind to mechanical energy. The kinetic energy of any particle is equal to one half its mass times the square of
its velocity,

K.E=½mv2 …………………….. (1)

Where,
K.E = kinetic energy
m = mass
v = velocity,
M is equal to its Volume multiplied by its density ρ of air

M = ρAV ………………….. (2)

Substituting eq. (2) in eq. (1)
We get,
K E = ½ρAV.V2
K E = ½ρAV3watts.
Where,
A= swept area of turbine.

ρ= density of air (1.225 kg/m3)
V=wind velocity.
For 35 Watt power, calculate design parameters of turbine, P=35 watts.
Considering turbine efficiency as 25% and generator efficiency 85%,
P = 35/ (0.25*0.85)
P= 166 watts.
= ½ρAV3
For wind velocity 6.67 m/s (18mph)
Density of air (1.225 kg/m3)
166 = ½*1.125*A*(6.67)3
A= 1 Sq.m
A = D*H (Sq.m)
D= diameter of the blade
Taking diameter as 1 meter, height of turbine can be calculated as
H=A/D =1/1
H =1m.
Diameter and height of wind turbine are 1m and 1m2 .
Design of Turbine Blades [6]
Wing width= diameter*0.14
= 1*0.14
= 0.140m = 140 mm
Wing chord = circumference*.09
= π*1*.09
= 0.282m = 282mm

VII. Design Considerations and Procedure

A. System Design

Design calculation of the VAWT is done by considering the speed of the air impacting blades of the turbine it starts rotating, blades connected to generator that generates the power. The power is used for some useful work.

B. Design of Blade

The blade is designed in semicircular shape so as one blade passes another blade comes in the position of first. 8 blades are used so as to use of maximum utilization of wind from air and moving vehicle.

A= d*h

d= diameter of the rotor (m)
h= height of the blades (m)
So area= (0.75*0.4)
= 0.3 sq. m.

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. Wind turbine blades have on aero foil – type cross section and a variable pitch. In the project eight blades with vertical shaft are used, it has a height & width of 750mm & 100cm respectively. The angle between two blades is 60. The material used for the blade is PVC pipe. This material is taken because it is low-cost and the weight of these pipes is also less, due to this the project weight also decreases and due to this the rotational speed also increases so as output. The weight of each blade is 200gm and therefore the total weight of 8 blades is 1.6 kg.

C. Design of Shaft

While designing the shaft it should be properly fitted to blade.. The shaft has diameter of 10mm so as to easily fixed in the disc and at the top and bottom ends mild steel plates are attached of thickness 2mm.
Stress acting on shaft

ρ = P / A

600 = 0.2898 / π/4 d*d
So,
d = 0.0201
Material used for shaft = Mild stee

D. Design 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 aluminum alloy 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: 226 mm
Inner diameter: 75 mm
Diameter of small pulley: 35 mm
Inner diameter: 10mm

E. Design of bearing

For the smooth operation of Shaft, bearing mechanism is used to.. The Bearing has diameter of 1cm. Bearing are generally provided for supporting the shaft and smooth operation of shaft. For Ease of Performance We have used Ball bearing

1) Arrangement of Various Components

Keeping into view the space restrictions the components should be laid such that their easy removal or servicing is possible.

F. Servicing Facility

The layout of components should be such that easy servicing is possible. Especially those components which require frequents servicing can be easily disassembled.

G. Height of Machine from Ground

Height of the turbine is determined by considering the fact that it should be able to take maximum air velocity created by the by the moving vehicles beside it.

H. Weight of Turbine

The total weight of turbine depends upon the selection of material components as well as the dimension of components. A heavier machine components would cause difficulty to rotate the turbine.

VIII. DESIGN

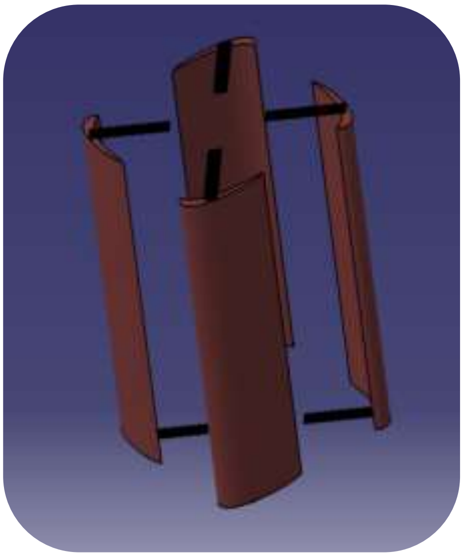


Fig. 1: Turbine blades

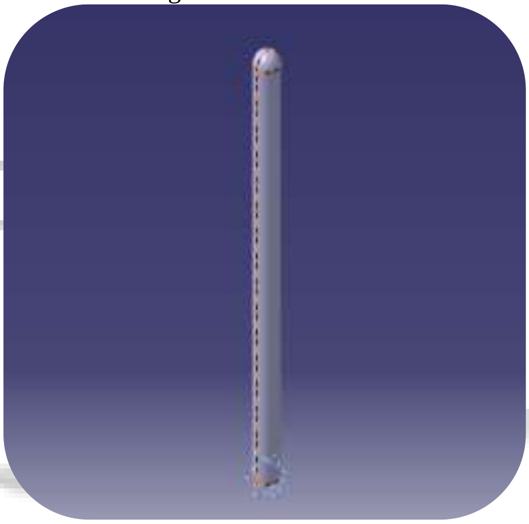


Fig. 2: Turbine shaft

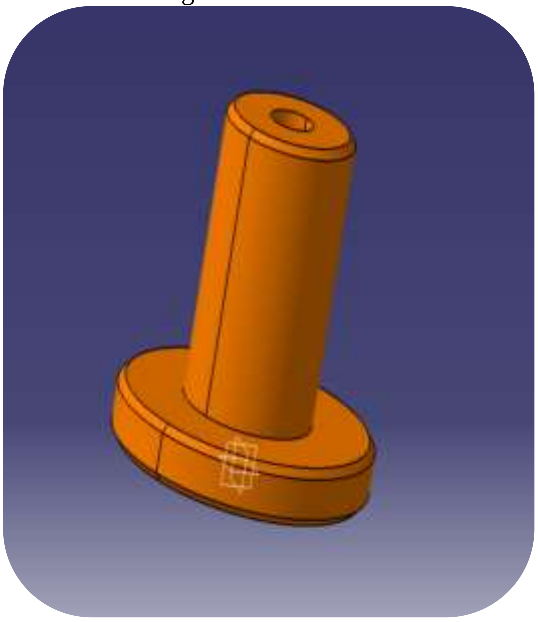


Fig. 3: Turbine Base

Fig. 4: Alternator

Fig. 5: Turbine Bush

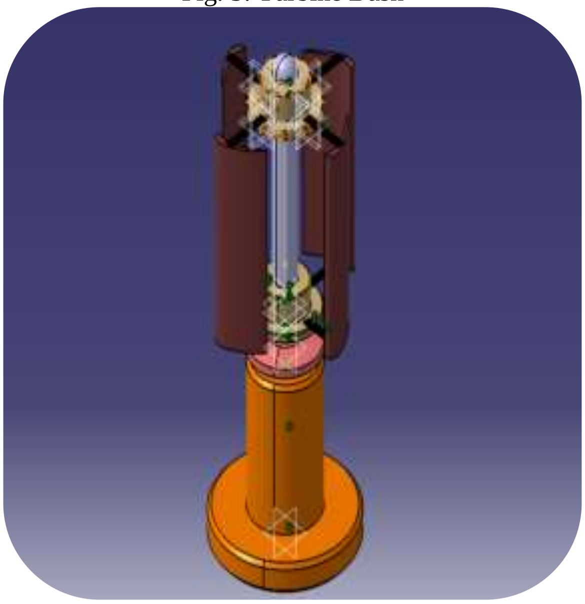


Fig. 6: Turbine Assembly view

IX. ADVANTAGES

1) Cheaper to produce than horizontal axis turbines.
2) More easily installed compared to other wind turbine types.
3) Transportable from one location to another.
4) Equipped with low-speed blades, lessening the risk to people and birds.
5) Function in extreme weather, with variable winds and even mountain conditions.
6) Permissible where taller structures are prohibited.
7) Quieter to operate, so they don't disturb people in residential neighbourhoods.
8) Simple in construction.

X. FUTURE SCOPE

Required data for further calculations to be measure i.e. Air flow velocity on highways at various locations. Selection of various components on the basis of calculated results. Different manufacturing works to be done on components, i.e. Rotor blades, shaft, hub etc. Manufacturing and assembling of actual model. Model to be tested at given specifications. i.e. actual air flow velocity on highways. Tested results to be calculate for report preparation

REFERENCES

[1] Muhammad Mahmood Aslam Bhutta , Nasir Hayat ,Ahmed Uzair Farooq , Zahid Hussain " Vertical axis wind turbine – A review of various configurations and design techniques" ,
[2] May - 2012 Volume 16, Issue 4, May 2012, Pages 1926-1939
[3] J. VigneshA. Simon Christopher T. AlbertJ. Sunil "Design and fabrication of vertical axis wind mill with solar system", Volume 21, Part 1, 2020, Pages 10-14
[4] Author links open overlay panel Anil Dhanola , H.C.Garg "Tribological challenges and advancements in wind turbine bearings: A review",Volume 118, December 2020, 104885
[5] Brian HandAndrew Cashman "A review on the historical development of the lift-type vertical axis wind turbine: From onshore to offshore floating application", Volume 38, April 2020, 100646
[6] Seralathan Sivamani, Mukesh Nadarajan ,R. Kameshwaran ,V. Hariram "Analysis of cross axis wind turbine blades designed and manufactured by FDM based additive manufacturing" Received 13 May 2020, Accepted 18 May 2020, Available online 12 June 2020.
[7] Kalakanda Alfred , Sunny Nallapaneni , Manoj Kumar "Vertical Axis Wind Turbine: Aerodynamic Modelling and its Testing in Wind Tunnel", Volume 93, 2016, Pages 1017-1023
[8] Iris HuiBruce , E. CainJohn , O. Dabiri "Public receptiveness of vertical axis wind turbines" Volume 112, January 2018, Pages 258-271
[9] Lin Wang , Athanasios Kolios , Takafumi Nishino , Theodore Bird "Structural optimisation of vertical-axis wind turbine composite blades based on finite element analysis and genetic algorithm", Volume 153, 1 October 2016, Pages 123-138

