VISVESVARAYA TECHNOLOGICAL UNIVERSITY

Jnana Sangama, Belgaum, Karnataka-590 014

A PROJECT REPORT
ON

"Design and Fabrication of Vertical Axis Wind Turbine for Highway Application"

Project Report submitted in partial fulfillment of the requirement for the award of the degree of

BACHELOR OF ENGINEERING
IN
MECHANICAL ENGINEERING

Submitted by

Abhishek	**1NH16ME003**
Ganesh S	**1NH16ME028**
Rohit Kumar Singh	**1NH16ME092**
Srevarun S	**1NH16ME093**

Under the guidance of
Mr. C Rakesh
Asst Professor

NEW HORIZON COLLEGE OF ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING
BANGALORE-560 103

2018-19

NEW HORIZON
COLLEGE OF ENGINEERING

Autonomous College Permanently Affiliated to VTU, Approved by AICTE & UGC
Accredited by NAAC with 'A' Grade, Accredited by NBA

DEPARTMENT OF MECHANICAL ENGINEERING

CERTIFICATE

It is certified that the Project work entitled **"Design and fabrication of Vertical Axis Wind Turbine for Highway Application"** carried out by **Abhishek (1NH16ME003), Ganesh S (1NH16ME028), Rohit Kumar Singh (1NH16ME092), Srevarun S (1NH16ME093)**, the bonafide students of **New Horizon College of Engineering, Bengaluru**, in partial fulfillment for the award of **Bachelor of Engineering in Mechanical Engineering** of the **Visvesvaraya Technological University, Belgaum** during the year **2018-2019.** It is further certified that all corrections/suggestions indicated for internal assessment has been incorporated in the report deposited in the department library. The Project has been approved as it satisfies the academic requirements in respect of Project Work prescribed for the **Bachelor of Engineering degree.**

Signature of the Guide	Signature of the HOD	Signature of the Principal
C Rakesh	**Dr. M S GANESHA PRASAD**	**Dr. MANJUNATHA**
Asst. Professor	Dean, Prof. and HOD-ME	Principal
Dept. of Mechanical Engineering.	Dept. of Mechanical Engineering.	NHCE

Name(s) of the student:	University Seat Number:
Abhishek	1NH16ME003
Ganesh S	1NH16ME028
Rohit Kumar Singh	1NH16ME092
Srevarun S	1NH16ME093

External Viva

Examiner **Signature with date:**

1.

2.

ACKNOWLEDGEMENTS

We thank the Lord Almighty for showering His blessings on us.

It is indeed a great pleasure to recall the people who have helped us in carrying out this project. Naming all the people who have helped us in achieving this goal would be impossible, yet we attempt to thank a selected few who have helped use in diverse ways.

We wish to express our sincere gratitude to **Dr. Manjunatha**, **Principal**, **NHCE, Bangalore**, for providing us with facilities to carry out this project.

We wish to express our sincere gratitude to **Dr. M S Ganesha Prasad Dean, Prof. & HOD-Mechanical Engg.**, for his constant encouragement and cooperation.

We wish to express our sincere gratitude to our teacher and guide **Mr. Rakesh C**, **Asst. Professor** in the Department of Mechanical Engg., NHCE, for his valuable suggestions, guidance, care & attention shown during the planning, conduction stages of this project work.

We express our sincere thanks to project coordinators, all the staff members and non-teaching staff of Department of Mechanical Engg., for the kind cooperation extended by them.

We thank our parents for their support and encouragement throughout the course of our studies.

DECLARATION

I hereby declare that the entire work embodied in this dissertation has been carried out by me and no part of it has been submitted for any degree of any institution previously.

Date:

Place: Bangalore

Abhishek 1NH16ME003

Signature of the student

Srevarun.S 1NH16ME093

Signature of the student

Rohit Kumar Singh 1NH16ME092

Signature of the student

Ganesh.S 1NH16ME028

Signature of the student

CERTIFICATE

This is to certify that the above declaration made by the candidate is correct to the best of my knowledge and belief.

Place: Bangalore
Date: 27/05/2019

C.RAKESH
Assistant Professor,
Department of Mechanical Engg,
N.H.C.E, Bangalore.

CONTENTS

Chapters	Page no.
1. Introduction	
1.1 Importance	1
1.2 Wind energy	1
1.3 Advantage of wind energy	2
1.4 Limitations of wind energy	2
1.5 Horizontal axis wind turbine	3
1.6 Vertical axis wind turbine	
1.6.1 Savonius wind turbine	3
1.6.2 Darrieus wind turbine	3
1.7 Objectives	5
2. Literature Review	
2.1 Literatures referred	6
2.2 Summary	8
3. Methodology	10
4. Experimental Equipment and Instrumentation	
4.1 Components of full view VAWT	11
4.1.1 Base plates	11
4.1.2 Shaft	12
4.1.3 Blades	12
4.1.4 Blade Shaft connectors	13
4.1.5 Neodymium magnets	13
4.1.6 Deflectors	14
4.1.7 Spur gears	14
4.1.8 Nylon cushion	15
4.1.9 Bearings	15
4.1.10 Generators	15
4.2 Design	16
4.3 Model	17
5. Results and discussions	
5.1 Design for strength	18
5.2 Results	20
6. Conclusion	21
7. Scope of future work	22
8. References	23

LIST OF FIGURES

FIGURE NO.	FIGURE NAME	PAGE NUMBER
1.1	Horizontal-axis wind turbines	3
1.2	Savonius Wind Turbine	4
1.3	Darrieus Wind Turbine	4
4.1	Base plates	11
4.2	Shaft	12
4.3	Blades	13
4.4	Blade-Shaft connector	13
4.5	Neodymium magnets	14
4.6	Deflectors	14
4.7	Spur gears	15
4.8	12V generator	15
4.9	Isometric view of VAWT	16
4.10	Top view, Isometric view, Front view of VAWT	16
4.11	Model of VAWT	17
4.12	Gears and generator assembly	17

LIST OF TABLES

Table	Description	Page no.
5.1	Calculations results	20
5.2	Turbine specifications	20

List of symbols

V- Air Velocity [m/s]
A - Turbine Swept area [m^2]
D - Rotor Diameter [m]
H - Rotor Height [m]
ρ - Air Density [kg/m^3]
ω - Angular Speed [rad/s],
R - Rotor Radius [m]
N - Number of Blades
c - Blade Chord [m]
L - Blade length [m]
λ - Tip speed ratio
Pw - power in wind [Watts]
Pm - mechanical power [Watts]
ς - solidity
Fl- Lift force which causes blade to lift [N]
Cl- coefficient of lift
Fd - drag force which resists the wind speed [N]
Cd - coefficient of drag
T - Torque [Nm]

CHAPTER-1

INTRODUCTION

Design, fabrication and testing of Vertical Axis Wind Turbine will be the ongoing third year undergraduate mini-project. Here main purpose will be enhancing the performance of the Vertical Axis Wind Turbine by designing and fabricating with a low cost and to improve the efficiency of the turbine.

1.1 Importance of the project

Energy is always a hot topic in the news today, increased consumption, increase cost, depleted natural resources, our dependencies on foreign sources, and the impact of it on the environment and danger of global warming. Something it has to change. Wind energy has the great potential to lesser our dependence on traditional resources like oil, gas and coal and to do it without as much damage to the environment. Alternative energy sources, are also called renewable resources, deliver power with minimal impact to the environment. These sources are typically more green/clean than traditional method such as oil or coal.

1.2 Wind Energy

According to the U.S. Department of Energy wind has seen the fastest growing source of electricity generation in the world through the 1990s.

With untapped wind resources all over the country and the declining wind energy cost in India is moving in the 21st century with initiative accelerate the progress of the wind technology and reduces its cost, to create new job, and to improve quality.

1.3 Advantages of wind energy:

1. Wind is free.
2. Latest technologies make energy production much more efficient.
3. Wind turbines take up less space than the average station. The turbines can be placed in remote locations, such as offshore, mountains and deserts.
4. When combined with other alternative energy sources, wind can provide a reliable supply of energy.

1.4 Limitations of Wind Energy

1. Wind sites are mostly located in remote areas, which are far from cities where the electricity is required. Transmission lines have to be built to bring the electricity from wind farm to city.
2. Wind power still needs to compete with conventional sources on a cost basis.
3. Wind resource development will not be most profitable use of land. Land which is suitable for turbine installation must compete with other uses for the land.

1.5 Horizontal axis wind turbine (HAWT)

Horizontal axis wind turbines have the main rotor shaft and also electrical generator is at the top of a tower, and it must be pointed into the wind. Small turbine is pointed by a simple wind vane while large number of turbines generally use a wind sensor coupled with servo motor. Most have a gearbox which turner sometimes tilted forward in the wind a small amount.

The rotor, torque and speed characteristics can be controlled and optimized in modern Horizontal axis wind turbines by changing pitch angle of rotor blades. It is done by using mechanical and electric blade pitch system. This technique improves the performances of wind turbine while protecting turbine against extreme wind conditions and over speed.

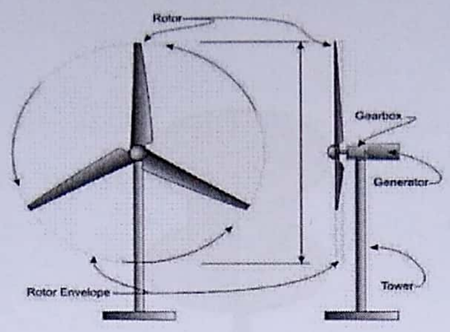

Fig. 1.1 – Horizontal-axis wind turbines

1.6 Vertical-axis wind turbines (VAWT)

Vertical-axis wind turbines have the main rotor shaft placed vertically. One advantage of this arrangement is that the turbine does not need to be pointed into the wind to be effective, which is an advantage on site where the wind direction is highly variable example when the turbine is integrated in a building. The generator also gearbox is being placed near ground using direct drive from a rotor assembly to the ground gearbox to improve the accesibility for the proper maintenance.

Vertical-axis wind turbines offer a number of advantages over traditional horizontal-axis wind turbines. They can be packed closer together, allowing more in given space. They are Omni-directional, and they produce lower force on this support structure. They do not require as much wind to generate power so allowing them to be close to ground where wind speed is lower. Because of closer to the ground they are maintained and can be installed on chimneys and similar tall structures.

1.6.1 Savonius Wind Turbine

Savonius vertical axis wind turbine is the slow rotating high torque machine with two or even more scoops are used in high reliability lower efficiency power turbines. Most turbines use lift generated by airfoil-shaped blade to drive a rotor, the Savonius uses drag and thus cannot rotate faster than the approaching wind speed. So the task is to be increase the efficiency.

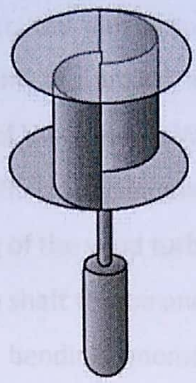

Fig. 1.2 – Savonius Wind Turbine

1.6.2 Darrieus Wind Turbine

Darrieus Wind Turbine are commonly known as the Eggbeater turbine. It was invented by George Darieus in 1931. A Darieus is a highspeed low torque machine suitable for generating alternating current electricity. Darieus generally requires manual push thus some external powers source to starting the turning as the starting torque is very low. Darieus has the two oriented blades revolving around a vertical shaft.

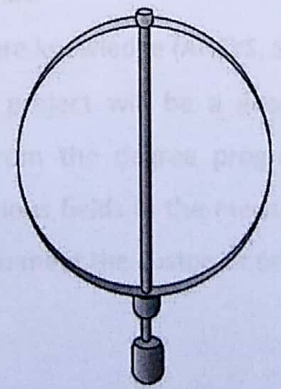

Fig. 1.3 – Darrieus Wind Turbine

1.7 Objective

In this present project, the aim is to fabricate a low cost Vertical Axis Wind Turbine and mainly this project includes following sub processes:

1. Designing of Vertical Axis Wind Turbine
2. Flow and efficiency analyzing
3. Fabricating of the wind turbine
4. Testing the shaft torque and rpm
5. Analyzing bending moment, stresses of the completed structure

By doing the project the expected outcome is to achieve certain primary objectives as well as secondary objectives which are related to power generation in India. So, the aim of the present project is to optimize the efficiency of the wind turbine and create a wind turbine which can perform in any area.

A vast area of mechanical engineering field is covered in this project. After completing the project, the knowledge about the following fields will be covered:

1. Design of machine elements
2. Strength of materials
3. Simulation software knowledge (ANSYS, Solid Works)

Finally, this present project will be a good opportunity to apply the knowledge gained from the degree program with a real application. Because it covers various fields in the mechanical engineering and it will be a huge challenge to meet the customer requirements as well.

CHAPTER-2

LITERATURE REVIEW

2.1 Literatures Referred

Huseinbani,et.al[1]: This work presents experimental study of using a 3 bladed helical turbine specially designed, manufactured for producing electricity from wind energy of moving car on highway for lighting purpose such as the highway light traffic signal and light guide lines. Result show that vertical axis wind turbine prototype has produced up to 39 Watt of power from vehicle moving on the highway which produced average wind speed of 4.2 m/ s. The turbine power curve is produced from the data also based on best fit to the power curve. The efficiency of 33.2 percent is obtained which is promising for future development of work in commercial scale.

Menka R Mohan,et.al[2]: In this paper the generation of electric energy is achieved by using vertical axis wind turbine using the force which is created by moving vehicles. Two different types of blade model totally made as a hybrid in VAWT which increase the efficiency in wind energy utilization. Due to the hybrid specialty, drag and lift are increased, the blades rotate automatically even with very small wind speed. The power is generated by the VAWT is utilized for highway application and also the excess power will be injected into the grid or local area. Power stored in the battery bank which is placed under windmill, utilized at night time for lighting on highway.

NC Baista,et.al[3]: The lift-type VAWT is unable to self-start at less wind speed without extra component. Hence new blade profile for Darrieus type VAWT is presented in this paper capable to self-starting at low wind speed. The methodology is developed in order to compare the new blade with another known airfoil.

M Zhng,et.al[4]: The full effect of blades number on performances of drag-type vertical axis wind turbine is studied by Ansys numerical simulation it involves 3-blade, 5-blade and also 6-blade VAWT. The optimized width of blade for each vertical axis wind turbine at max power efficiency is obtained and simulation for the wind turbine with different numbers of blades is conducted with turbine radius of 2m at the inlet wind speed 6 m/s.

MQ Islam,et.al[5]: The present research work concern with the dynamic condition of multi s shaped bladed rotor at different Reynolds No. The full investigation on wind loading, aerodynamic effect on the 4, 5 and 6 bladed shaped vertical axis vane type rotors has been conducted with the help of open circuit subsonic wind tunnels. For the different bladed rotor, the flow velocities were varying from 5m/s to 10m/s covering the Reynolds number up to 1.30 x 100. Finally, then nature of predicted dynamic characteristics has been analyzed by comparing with the existing research work.

Parikshit Kailash Ghogare,et.al[6]: The thesis describes the strategy to develop a 2DCFD model of Darrieus Vertical Axis Wind Turbines using a NACA 6409 airfoil. ANSYS Fluent was used to simulate the model and analyze the study. The sliding mesh method is used for the simulation for which a rotating region is created in a large domain. Use of unsteady solver (Transient solver) is done to capture the dynamic stall phenomenon and the unsteady rotational effects. A very fine, high quality mesh is produced inside the limit layer of the airfoil so as to proficiently comprehend the close field impacts and get the outcomes in like manner. A thorough work must be done on the designing of the turbine measuring so as to accomplish exact simulation of the entire setup.

Lahu P. Maskepatil,et.al[7]: Wood, Glass fiber, carbon fiber sandwich composite material are different materials available for small wind turbine blades. Strength, density, cost availability are the important properties to be considered during material selection of blade. The selection of material for wind turbine blade is a significant stage in blade design. This paper introduces a basic Analytic Hierarchy Process for material selection for the small wind turbine blade. In this work AHP is effectively connected for material determination for small wind turbine blade.

Mishnaevsky L,et.al[8]: This is based on the requirements towards the wind turbine materials as available materials are reviewed. Apart from the traditional composites for wind turbine blades hybrid and Nano-engineered composites are discussed. Manufacturing technologies for wind turbine composites as well their testing and modeling approaches are reviewed.

J Damota,et.al[9]:. From the data extracted it is known that the different model that are working with different geometries differentiating between Savonius Darrieus, models dedicated to Offshore technology.

2.2 Summary

These are the various findings from the above journals referred ;

- The paper focuses on the study and the development of new blades and their profiles for Darrieus VAWT which is capable to self-start without use of extra component external energy input. [1]

- Through the above analysis for the wind turbine with the same turbine radius and the wind speeds of 6m/s it concludes the stability of the wind turbine and the optimum power efficiency increase with the number of blades for turbine with the same radius and the inlet wind speed. [2]

- The stability of the wind turbine, the optimum power efficiency increases. [3]

- With the number of blades for turbine with the same radius and the inlet wind speed. [4]

- The important thing that the simulation tells that this airfoil should be optimized. So, there are many techniques to avoid boundary layer separation in order to increase the gain from the model. A very good option. [5]

- With the airfoil would to use a helical design of the blade in 3 dimensions. This will also allow the blade to produces coefficient of moment at every rotation angle very low wind will be wasted without interacting of blades.[6]

- AHP methods is proved practical enough for selecting these materials for wind turbine blade. It is extremely useful for making the decisions in case of complicated criteria and vast alternative available but the Weights given to the criteria by the different individual according to his requirement may change the result. [7]

- If conclusion can be drawn is that the VAWT technology will be with us in the future and can be seen all around us as has happened with other renewable technology for electricity production thus becoming part of future renewable energy range and contributing to the reduction of CO2 production. [8]

CHAPTER-3

METHODOLOGY

The goal of this present project was to design a vertical axis wind turbine (VAWT) that could generate power under relatively low wind velocities and be environmentally friendly at a low cost. To accomplish this goal, the objectives were to firstly, analyze how different geometry of the wind turbines within various enclosures affect wind turbine power output secondly, to see how the rotations per minute can be increased and thirdly, see a new application of VAWT other than its traditional application. To meet these objectives, the tasks were to: -

1. Complete background research on wind turbine data
2. Design turbine blade designs
3. Design model roof structure
4. Create experimental set up
5. Manufacture parts and build model house
6. Test run the model
7. Seek a non-traditional application of our VAWT

CHAPTER-4

EXPERIMENTAL EQUIPMENTS AND INSTRUMENTATIONS

4.1 Components of full-scale VAWT

The components of the full-scale VAWT are listed below:

1. Base plates
2. Shafts
3. Blades
4. Blade- shaft connectors
5. Neodymium magnets
6. Deflectors
7. Spur gear
8. Nylon cushion at ends
9. Bearings
10. Generator

4.1.1 Base plates

The two base plates are made of MS-steel and the structure stands approximately 3 feet high. The bottom-most base plate has a diameter of around 48cm and the other has a diameter of around 40cm. By itself the bases will not support the torque and moments produced from our wind turbine, so three base extensions are provided to maintain stability.

Fig. 4.1 –Prototype model of designed Base plates

4.1.2 Shaft

There are two shafts-Outer hollow shaft and inner solid shaft having diameters 1.5 cm and 1 cm respectively. It is made of Aluminium material and the shaft contains two ring magnets (10mm*20mm) at a distance of about 1.2-1.4 cm between them.

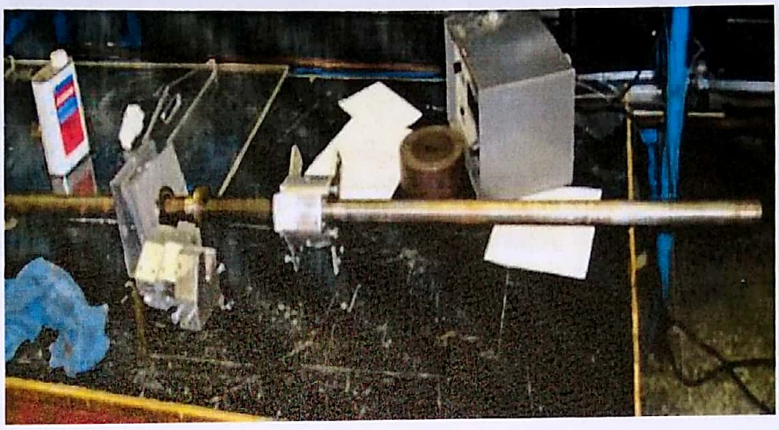

Fig. 4.2 – Prototype model of designed Shaft

4.1.3 Blades

Selecting appropriate blades for our vertical axis wind turbine is one of the most important design decisions. Different profiles provide different advantages and disadvantages that must be considered. Wind tunnel prototype testing results will provide information that will be used to choose the optimal blade profile for a self-starting application.

Once a profile was selected, 3 blades will be machined from Aluminium flat-plate of 12mm thickness into an accurate representation of the selected airfoil. The machining process includes grinding the 12mm plate to 5-6 mm thickness.

The blades are then twisted to the required angle by fixing one of the ends to a vice and using a wrench to achieve the required blade angle followed by cross cutting of extra portion.

Fig. 4.3 – Prototype model of designed Blades

4.1.4 Blade Shaft connectors

Aluminium will be used for the six radial connecting arms to maintain a lightweight assembly with minimal inertial, moment, and centrifugal forces. The connecting arms provide a means to mount the blades to the centre mounts and thus the centre shaft. Tig- welding is performed to keep the blades in-tact with the connectors.

Fig. 4.4 – Prototype model of designed Blade-Shaft connector

4.1.5 Neodymium magnets

Eight neodymium magnets are provided on either side of the base plates. The neodymium magnets are installed to provide the extra torque and reduce the coefficient of friction. This concept is inspired by maglev magnetic train levitation of placing alternating like and unlike poled magnets to produce additional torque.

Fig. 4.5 –Neodymium magnets

4.1.6 Deflectors

Two deflectors are used for self-staring of the turbine at low wind speeds. Sheet metal is made into a hemispherical shape. These deflectors are welded onto the main shaft.

Fig. 4.6 – Prototype model of designed Deflectors

4.1.7 Spur gears

Spur gears are a type of cylindrical gear, with shafts that are parallel and coplanar, and teeth that are straight and oriented parallel to the shafts. They are the simplest and most common type of gear – easy to manufacture which is suitable for a wide range of applications. The teeth have an involute profile which means that spur gears only produce radial forces (no axial forces), but the method of tooth meshing causes high stress on the gear teeth and high noise production. Hence spur gears are typically used for lower speed applications, although they can be used at almost any speed.

Fig. 4.7 – Prototype model of Spur gears

4.1.8 Nylon cushion

This is used to prevent the magnetic power beyond second base plate.

4.1.9 Bearings

It is a type of rolling-element in which the separation between the bearing races is maintained using small balls. It is used to reduce rotational friction and support radial and axial loads. Because the balls are rolling they have a much lower coefficient of friction when compared to two flat surfaces were sliding against each other.

They lower the load capacity for their size than other kinds of rolling-element bearings due to very small contact area between the balls and races.

4.1.10 Generator

A generator is a device that is used to convert mechanical energy into electrical power which can be used in an external circuit. The specification of the generator used in our VWAT is 12V-500rpm.

Fig. 4.8 – 12V generator

4.2 Design

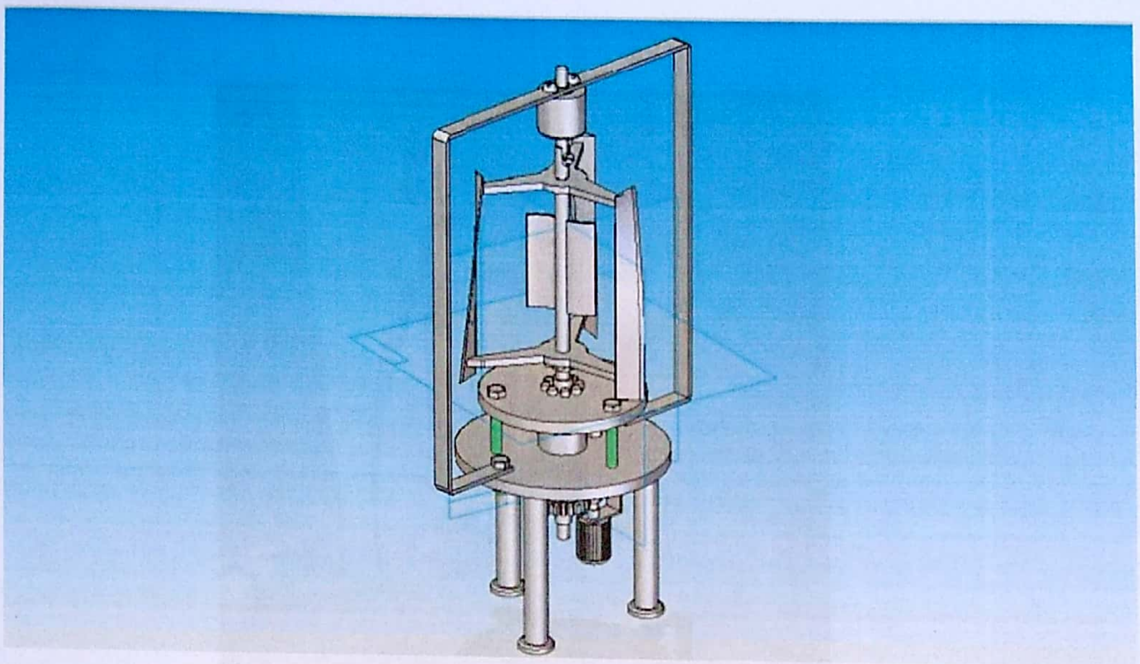

Fig. 4.9– Isometric view

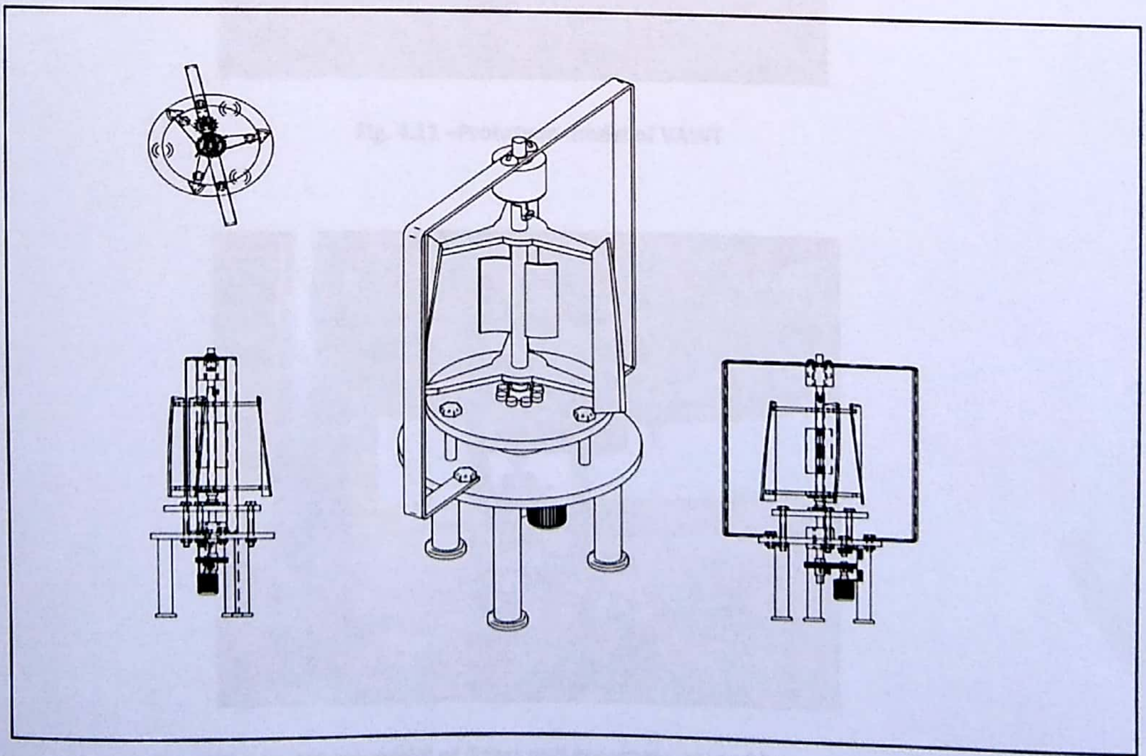

Fig. 4.10 – Top view, Isometric view, Front view

4.3 Model

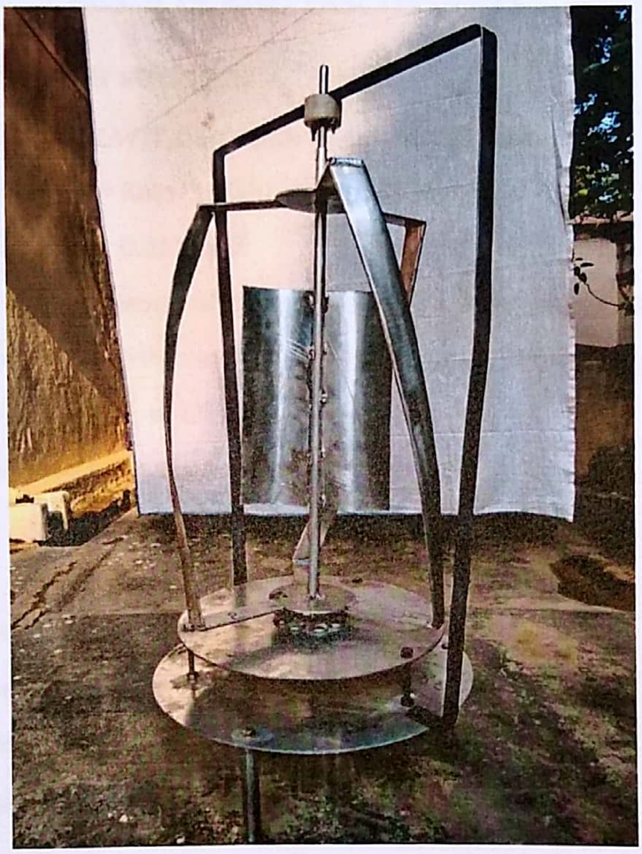

Fig. 4.11 –Prototype model of VAWT

Fig. 4.12 – Prototype model of Gears and generator assembly

CHAPTER 5

RESULTS AND DISCUSSIONS

5.1 Design for strength:

Design for the VAWT starts with swept area (A) calculation,

A = H*D (H= Rotor Height, D= Rotor Diameter)

$A = 0.56 * 0.38 = 0.2128\ m^2$

Design and calculation of straight bladed VAWT is performed by considering the speed of wind that will hit the blade, and also kinematic viscosity (ϑ), air density (ρ) and no. of blades.

For this project it is assumed that,

TSR (λ) = 1 (TSR = 1-4 for small scale generation

TSR = 5- 9 for Large scale generation)

Number of blades (Nb) = 3

Wind velocity, (v) = 6 m/s

Kinematic viscosity, (ϑ) = 0.0000178 kg/ms

Air density, (ρ) = 1.29 kg/m^3

Power in the wind is,

$Pw = 1/2 * \rho * A * v^3$

$Pw = 1/2 * 1.29 * 0.2128 * 216 = 27.57\ W$

Mechanical power can be calculated by formula,

$Pm = 1/2 * \rho * A * 16/27 * v^3$

$Pm = 1/2 * 1.29 * 0.2128 * 16/27 * 216 = 16.34\ W$

Where, 16/27 is Betz limit, this value was given by Albert Betz who was physicist in 1919, and he proposed that 16/27 = 0.599 is maximum power of efficiency of wind turbine which convert kinematic energy to mechanical energy.

Angular velocity (ω) can be calculated as,

$\omega = \lambda * v/R$

$\omega = 1 * 6/0.19 = 31.57$ rad/sec

$N = \omega * 60/2\pi$

$N = 31.57 * 60/2\pi = 301.55$ rpm

Chord length, (C) can be calculated as:

$C = \varsigma * R/Nb$

$C = 0.6 * 0.19/3 = 0.04$ m

Where solidity, $\varsigma = 0.6$ as Reynolds no is 1.6*10^5

Lift force which causes blade to lift

$Fl = 1/2 * Cl * \rho * C * \omega^2$

$Fl = 1/2 * 0.80 * 1.29 * 0.04 * 31.57 * 31.57 = 20.57$ N

Where Cl = coefficient of lift = 0.80

The drag force resisting the wind speed is,

$Fd = 1/2 * Cd * \rho * C * \omega^2$

$Fd = 1/2 * 0.04 * 1.20 * 0.04 * 31.57 * 31.57 = 1.02$ N

Where Cd= coefficient of drag =0.04

Torque to be transmitted is,

$T = Pm * 60/2\pi * N$

$T = 16.34 * 60/2\pi * 301.55 = 0.517$ Nm

5.2 Results

Table 5.1: Calculation results

Serial No.	Wind speed (m/s)	Power generated (W)
1	7	28.2
2	8	42.09
3	9	59.93

Table 5.2: Turbine specifications

Wind rotor	Rated power	35W
	Rated speed	6 m/s
	Rotor Diameter	.38m
	Swept area	.2128 m^2
	Gear box type	Spur gear
Generator	Type	DC Generator
	Speed	500 rpm
	Voltage	12V
Turbine Blade	Type	Darrieus
	Number of Blades	3
	Blade material	Aluminium 6061
Blade dimension	length	0.56m
	radius	0.38m

CHAPTER-6

CONCLUSION

VAWT technology undoubtedly will be with us in the future, and can be seen all around us, as has happened with other renewable technologies for electricity production, such as HAWT and PV, thus becoming part of the future renewable energy range and the business network, contributing to the reduction of CO_2 production and economic growth.

From the studies devoted to the types of optimal generators for producing electricity from wind energy in urban environments it can be drawn that the desired features are:

- High mechanical and electrical efficiency (including the operation of main charge).
- Compact size and high specific torque / power.
- Lower noise and vibration.
- Cheap and easy to manufacture and install.

The possibility that this type of design is scalable, together with its low maintenance and compact size, opens up to the use of many powers and sizes in wind turbines and can be used in all kinds of applications.

CHAPTER-7

Scope of Future work

The VAWT technology is sliding into the use in small generating installations, especially in urban environments that currently have winds that are not exploited. There are studies about the Omni directional guide-vane which make power, speed and torque increase markedly in these sorts of environments. Employing VAWT in hybrid power generation system can be the solution at many locations since the cost of this system is considered to be lower than the use of both individual technologies.

So, our main focus is to provide economical free and ecologically friendly irrigation of agricultural lands for farmers without any power or fuel consumption. In order to do that we will convert the acquired rotational energy from our VAWT into a linear compressed form to be able to run a sprinkler.

REFERENCES

[1] Ehab Hussein Bani-Hani, Ahmad Sedaghat, Feasibility of highway energy harvesting using a Vertical Axis Turbine, February 13,(2018), (Taylor & Francis E-Journals)

[2] Mahasidha Birajdar, Vertical Axis Wind Turbine for Highway Applications, September (2016), (ResearchGate)

[3] N.C. Batista, R. Melício, Blade Profile for Darrieus Wind Turbines Capable to Self-Start, (2010), (IEEE Xplore)

[4] M Zheng, Y. Li, H. Teng, Effects of Blade No. on Performance of Drag-Type Vertical Axis Wind Turbine, Applied Solar Energy 52(4):315-320, December (2016), (ResearchGate)

[5] Z Afroz, M.Q. Islam, Aerodynamic studies on Multi Bladed S-Shape Vane Type Rotor, January (2012), (ResearchGate)

[6] Swamy, N.V.C., Fritzsche A.A., Aerodynamic Studies on Vertical Axis Wind Turbine, September 7-9, (1976)

[7] Parikshit Ghogare, Vertical Axis Wind Turbine Analysis and Simulation, August (2016), (ProQuest Engineering E-Journals)

[8] Lahu P. Maskepatil, Selection of Material for Wind Turbine Blade by Analytics Hierarchy Process Methods, (2014), (Scientific.Net)

[9] Mishnaevsky L, Branner K, Materials for Wind Turbine Blades: An Overview, November 9, (2017), (MDPI)

[10] J. Damota, I. Lama, Vertical Axis Wind Turbines: Current Technologies and Future Trends, March (2015), (ResearchGate)

NEW HORIZON COLLEGE OF ENGINEERING

Autonomous College Permanently Affiliated to VTU, Approved by AICTE & UGC

Accredited by NAAC with 'A' Grade, Accredited by NBA

LIBRARY & INFORMATION CENTRE

CERTIFICATE ON PLAGIARISM CHECK

1	Name of the Student	Abhishek Rohit Kumar Singh	Ganesh S Srevarun S
2	USN	1NH16ME003 1NH16ME092	1NH16ME028 1NH16ME093
3	Course	UG	
4	Department	ME	
5	Mini Projects/Project Reports/ Ph.D Synopsis/Ph.D Thesis/ Paper Publication(N/I) / Internship Report	Mini Project	
6	Title of the Document	Design and Fabrication of Vertical Axis Wind Turbine for Highway Application	
7	Similar Content(%)identified	22%	
8	Acceptable maximum limit (%) of similarity	30%	
9	Date of Verification	25.05.2019	
10	Checked by (Name with signature)	Mr. Ramanjineya	
11	Specific remarks, if any :	1st Attempt (23 Pages only)	

We have verified the contents as summarized above and certified that the statement made above are true to the best of our knowledge and belief.

Head-Library and Information Center

Head Library and Information Center
New Horizon College of Engineering
Ring Road, Kadubisanahalli, Bellandur Post,
Near Marathalli, Bangalore-560 103