“DESIGN AND FABRICATION OF VERTICAL WIND TURBINE FOR POWER GENERATION AT HIGHWAY MEDIANS”

PROJECT REFERENCE NO. : 37S0033

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Introduction:

If the efficiency of a wind turbine is increased, then more power can be generated thus decreasing the need for expensive power generators that cause pollution. This would also reduce the cost of power for the common people. The wind is literally there for the taking and doesn't cost any money. Power can be generated and stored by a wind turbine with little or no pollution. If the efficiency of the common wind turbine is improved and widespread, the common people can cut back on their power costs immensely.

Since its creation, man has constantly tried to improve the windmill. As a result, over the years, the number of blades on windmills has decreased. Most modern windmills have 5-6 blades while past windmills have had 3–8 blades. Past windmill also had to be manually directed into the wind, while modern windmills can be automatically turned into the wind. To utilize the available wind resources and reduce the usage of non renewable energy resources, wind energy is by far the fastest-growing renewable energy resource. These wind turbines can be used to provide constant lighting. In most cities, highways are a faster route
for everyday commute and in need of constant lighting makes this an efficient way to produce natural energy.

This vertical-axis wind turbine incorporates 4 involute spiral blades in a configuration that utilizes the mass momentum of the wind to spin the blades around a central shaft. Force is applied to the blades by the wind both entering and leaving the turbine, allowing maximum extraction of energy from the wind. The unique nature of the involute spiral is that the wind is increasingly diverted into and out of a central vortex with no constriction in the path, only pushing the surfaces around. Other advantages to this particular design will be covered below at the base.

**Objectives of the project:**

The main objective is to harvest and recapture the maximum amount of wind energy from the automobiles running on the highways. The unused and considerable amount of wind is used to drive the vertical wind turbine, which will use the kinetic energy of the wind to produce the electrical energy. Increased turbulence levels yield greater fluctuations in wind speed and direction. Unlike traditional horizontal axis wind turbine (HAWT), vertical axis wind turbine effectively captures turbulent winds which are typical in urban settings. An effort is made to create a vertical axis wind mill of 500W capacity. Our aim is to design the turbine which will capture the maximum of wind in any direction by placing it at optimum place and height by considering both the cost and safety of the system. This system can be used in huge number to generate the huge amount of useful electrical energy. This energy can be stored and transferred to nearest rural places where we can fulfill the demand of electricity.

The thought of design directs us to look into the various aspects such as manufacturing, noise, cost which leads us to our additional aim of analyzing the system to overcome the usual technical glitches. The project brief involves the design of a small scale wind turbine that can be easily mass produced and fitted on every highway medians to aid electricity consumption.

**The design should provide the following:**

- Be able to generate a non-trivial electricity supply to the streetlights when operating. Excess electricity can be fed back into the national grid or charge secondary batteries.
- The scale of the turbine should be within the limits of the Indian highways.
- Designed to operate at suitable wind speeds typical to India weather in highways areas.
- Possess a fail-safe system as a consequence of an over-speed event.
Methodology:

Fabrication of vertical axis wind turbine (Involute Spiral) consists of different parts which are needed to be fabricated as parts of main assembly. Following are the parts of VAWT, to be fabricated.

- Blades- fabrication of blade consists of aluminium blades, steel pipes, aluminium sheet circular cross section base.
- Housing- fabrication of Housing consists of circular metal disc, bearing and metal rods.
- Adjustable Shaft- fabrication of adjustable shaft consists of hallow shaft, threaded solid shaft and guide rod.
- Lower column- fabrication of column consists of selecting the shaft and welding of supporting discs.
- Base- fabrication of base aims at providing a strong support to the turbine. Hence have flexibility in design in accordance with supporting strength.

Apart from the parts said above, certain materials and components are required during main assembly of Vertical Axis Wind Turbine, such as aluminium strips, threaded rod, bolts for fastening, rivets, bearing and metal paste.

Specification of the generator:

- 12-15 volt DC supply
- 2-5 A current output
- 300 rpm input
- 8mm shaft diameter
- Inbuilt voltage rectifier

Transmission system:

- The chain and sprocket system is used as the transmission system in this wind mill.
- The gear ratio of sprocket and cassette is 1:3
Fig: Final assembly of wind turbine  
Fig: Wind turbine at highway medians  
Fig: Vehicle passing through wind turbine
Results & Conclusions:

Data has been collected by the use of digital anemometer at different location on the highway medians. The changes were recorded at different height and different location. The graph given below gives the actual data collected in highway for wind velocity at different height during certain interval of time.

Fig: Graph between wind speed v/s time

The input power can be calculated by using the formula

\[ P = M \times \omega \]

Where, \( M \) - Input torque

\( \omega \) - Angular velocity

The angular velocity can be calculated by knowing the rpm of the blade shaft and the torque can be calculated by knowing the velocity of the wind.
Theoretically, the power output of any wind turbine is,

\[ P_a = \frac{1}{2} \rho AV^3 \text{ in watts} \]

\( \rho \) - Air density at that particular height and location, (normally 1.225 kg/m\(^3\))

A - Swept area by blades.

V - Wind velocity in m/s

Table: Wind velocity and the power output

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Wind velocity (m/s)</th>
<th>Power output (in watts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>56.9</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td>256.5</td>
</tr>
<tr>
<td>3</td>
<td>7</td>
<td>685.0</td>
</tr>
</tbody>
</table>

The efficiency of the wind turbine can be calculated by the formula

\[ Efficiency = \frac{output}{input} \]
Practically,

At 3 m/s wind velocity turbine is rotating at 110rpm which accounts for 68.9 watts according to the equation. Hence one can obtain an output of 60-90 watts with an average wind speed of 3-5m/s.

The graph given below gives the actual data collected in highway at different wind velocity.

![Wind velocity vs Voltage](image_url)

**Conclusion:**

Our work and the results obtained so far are very encouraging and reinforce the conviction that vertical axis wind energy conversion systems are practical and potentially very contributive to the production of clean renewable electricity from the wind even under less than ideal sitting conditions. It is hoped that they may be constructed used high-strength, low-weight materials for deployment in more developed nations and settings or with recyclable materials and local skills in less developed countries. The Involute wind turbine designed is ideal to be located at the highways medians to generate electricity, powered by wind. The heavy vehicle traffic gives it an advantage for more wind opportunity. With the idea of putting it on highway medians, it will power up street lights and or commercial use. In most cities, highways are a faster route for everyday commute with different places and in need of constant lighting makes this an efficient way to produce electrical energy.
Scope for Future Work:

An economical, small scale Vertical Axis Wind Involute Turbine is fabricated using aluminum sheet and mild steel materials etc. From test results of Vertical Axis Wind Turbine over a wide range of wind speeds, it is noted that this turbine produces 40 watts for a wind speed of 3-3.5 m/s and which can be even increased by following measures.

- Optimizing the design of blades so as to give better aerodynamics.
- Using a best alternator which produces more voltage for low rpm.
- Using gear mechanisms to increase rpm for alternator input and hence can have higher power output.
- Structural fabrication should be more accurate in order to have proper functions of windmill.
- Using fixed base system to reduce the weight of the whole system.

Thus a small scale turbine for energy needs can be satisfied with optimized involute shape Vertical Axis Wind Turbine or combination of Darrieus and Savonius type of Vertical Axis Wind Turbine.