IOSR Journal of Engineering (IOSR JEN) **www.iosrjen.org**
ISSN (e): 2250-3021, ISSN (p): 2278-8719,
|| Special Issue || June-2019, || PP 44-48 ||

Design, Analysis & Development of (Prototype) Vertical Axis Wind Mill

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Abstract: *A vertical axis wind turbine (VAWT) is to convert wind power into the useful form of energy by turbine blade. The Vertical axis wind turbines are effective than horizontal axis wind turbines as they require less space than horizontal blades and the turbines does not need to be pointed in direction of the wind for effective output. This is useful in a site where the wind direction is highly variable. The Maglev Wind Turbine is expected to bring wind power technology to the next level. Furthermore, the system can be suited in use for rural and urban areas of low wind speed regions. The wind speeds in most of Asian zone is much lower, especially in the cities. The present day methods are not sufficient to keep pace with ever increasing demand. The recent severe energy crisis has forced to think & develop the power generation by renewable sources (mainly wind power). This system can also be implementing on the highway and rooftop of buildings. In this project study of alternate configuration of wind turbine for power generation purpose.*

Keywords: *Vertical axis wind turbine, Maglev wind turbine, Renewable energy sources, Wind power.*

I. Introduction

Wind turbine is a device that utilizes wind energy to generate mechanical or electrical power. There are two types of wind turbines: Horizontal Axis Wind Turbine (HAWT) and Vertical Axis Wind Turbine (VAWT). HAWTs are the most commonly known types of wind turbines which operate parallel to the direction of the wind whereas VAWTs rotors operate perpendicular to the direction of wind and are very unpopular. Wind power is the conversion of wind energy into a useful form of energy using wind turbines. A wind turbine is a machine that converts the kinetic energy of the wind into mechanical energy. If the mechanical energy is used directly by machinery such as, a pump or a grindstone, the machine is usually called a wind mill. If the mechanical energy is converted to electricity, the machine is called a wind generator or a wind turbine. Vertical axis wind turbines have the main rotor shaft arranged vertically. The main advantage offered by this type of arrangement is that the turbine does not need to be pointed in the direction of the wind to be effective. This is useful in a site where the wind direction is highly variable. Since the shaft is vertical, the gear box and the generator can be placed near the International Journal of Infinite Innovations in Technology ground so that the tower does not need to support it and is hence, more accessible for maintenance.

They are difficult to mount on towers and hence, they are installed near the base, like a building rooftop. Since they are located closer to the ground than horizontal wind machines, the arrangement can take an advantage of the natural constructions and surrounding buildings to funnel the air and increase the wind velocity. The main disadvantage of the vertical axis wind machines is that the stresses in each blade change sign twice during each complete cycle. This reversal of stresses increases the likelihood of blade failure by fatigue. The objective of the present work is to study the characteristics of a specific type of vertical axis wind machine, namely, the Savonius rotor. The following section gives an introduction to this rotor and the definitions of the performance characteristics associated with it. Nowadays, we will ultimately need to search for renewable or virtually inexhaustible energy for the human development to continue. Renewable energy is generally electricity supplied from sources, such as wind power, solar power, geothermal energy, hydropower and various forms of biomass. These sources have been coined renewable due to their continuous replenishment and availability for use over and over again.

II. Objective

The objective of this project is to design and build a vertical-axis wind turbine to generate electric power. The vertical turbine has the advantage of being deployable in urban or other crowded zones, whereas horizontal-axis turbines require a large footprint due to the space needed for safe spinning of the blades.

III. Principle Of Operation

III.1) Working Principle:

The basic working principle of a wind turbine is when air moves quickly, in the form of wind, the kinetic energy is captured by the turbine blades. The blades start to rotate and spin a shaft that leads from the

hub of the rotor to a generator and produce electricity. The high speed shaft drives the generator to produce electricity. The low speed shaft of wind turbine is connected to shaft of high speed drives through gears to increase their rotational speed during operation. Using the effects of magnetic repulsion, spiral shaped wind turbine blades will be fitted on a rod for stability during rotation and suspended on magnets as a replacement for ball bearings which are normally used on conventional wind turbines. The energy that can be extracted from the wind is directly proportional to the cube of the wind speed.

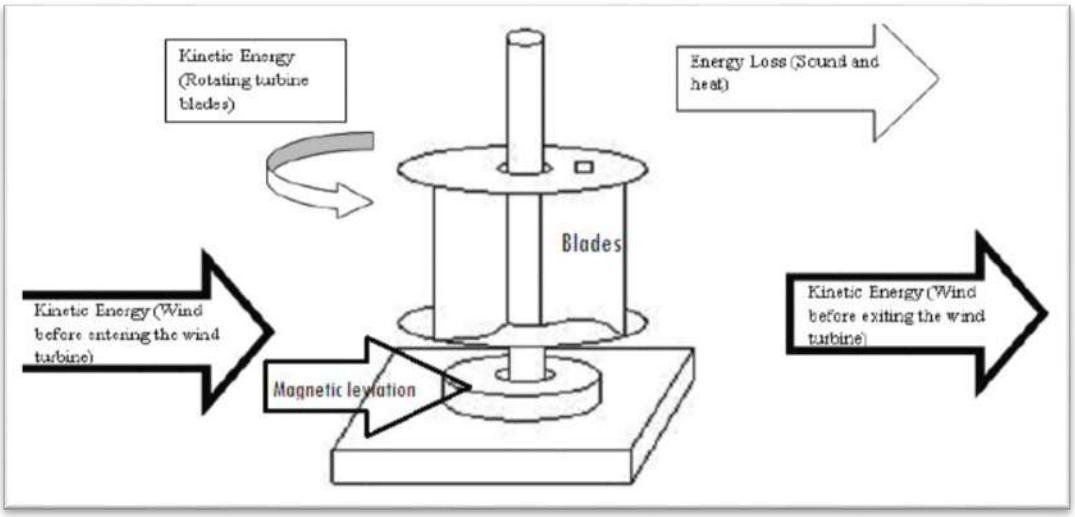

Fig 1: Working of maglev wind turbine.

Above figure gives an idea of MAGLEV WIND TURBINE. This phenomenon operates on the repulsion characteristics of permanent magnets. This technology has been predominantly utilized in the rail industry in the Far East to provide very fast and reliable transportation on maglev trains and with ongoing research its popularity is increasingly attaining new heights. Using a pair of permanent magnets like neodymium magnets and substantial support magnetic levitation can easily be experienced. By placing these two magnets on top of each other with like polarities facing each other, the magnetic repulsion will be strong enough to keep both magnets at a distance away from each other. The force created as a result of this repulsion can be used for suspension purposes and is strong enough to balance the weight of an object depending on the threshold of the magnets. Power will then be generated with an axial flux generator, which incorporates the use of permanent magnets and a set of coils. The generated power is in form of DC, stored in battery, this can be used to directly supply the DC loads and can also be converted to AC using inverter to supply AC loads. It can be used as OFF grid and ON grid as shown in above figures. Wind power is a proven and highly effective way to generate electricity. Maglev technology is the most efficient means of transferring kinetic energy to generate electricity. The vertical axis wind turbine platform floats on a magnetic cushion with the aid of permanent- magnet suspension and a companion linear synchronous motor. This technology eliminates nearly all friction and delivers maximum wind energy to the downstream linear generator.

IV. Analysis

Static analysis is used to determine the displacements, stresses, strains, and forces in structures or components caused by loads that do not induce significant inertia and damping effects. The kinds of loading that can be applied in a static analysis include externally applied forces and pressures.

IV.1) Structural Analysis of shaft

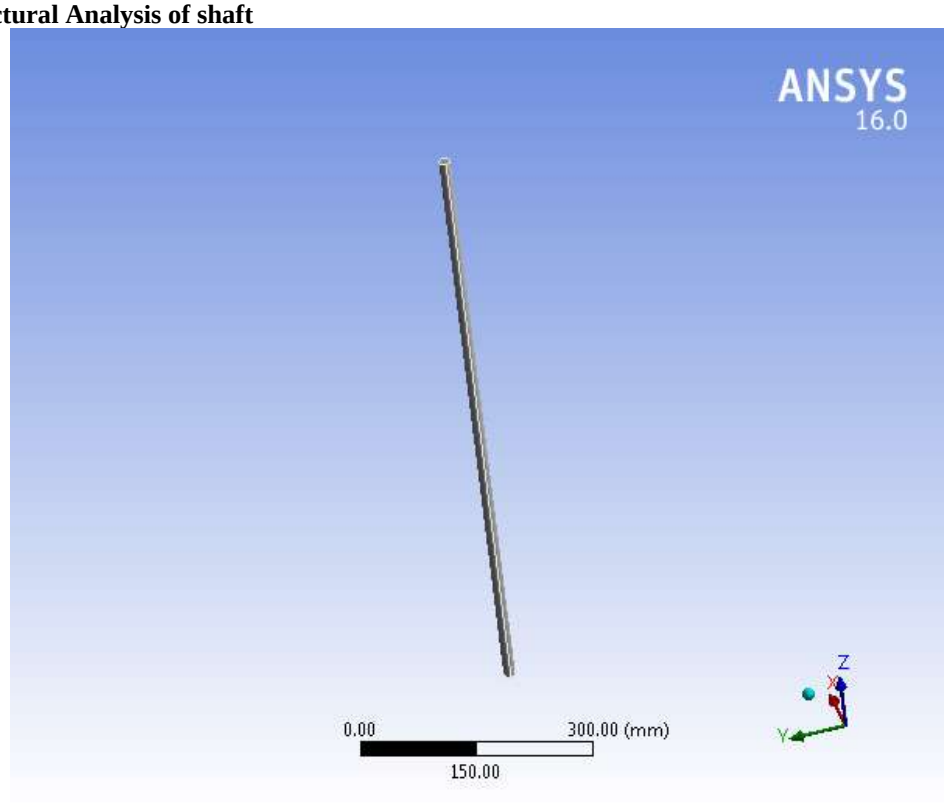

Fig 2: Model of shaft for analysis

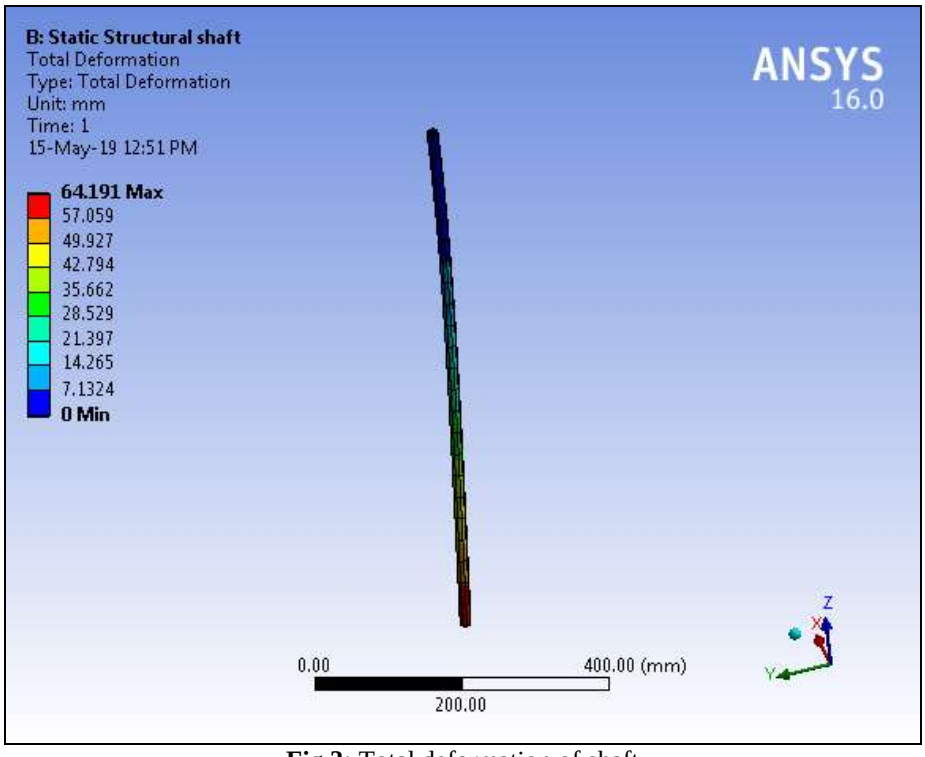

Fig 3: Total deformation of shaft

IV.2) Structural Analysis of blade

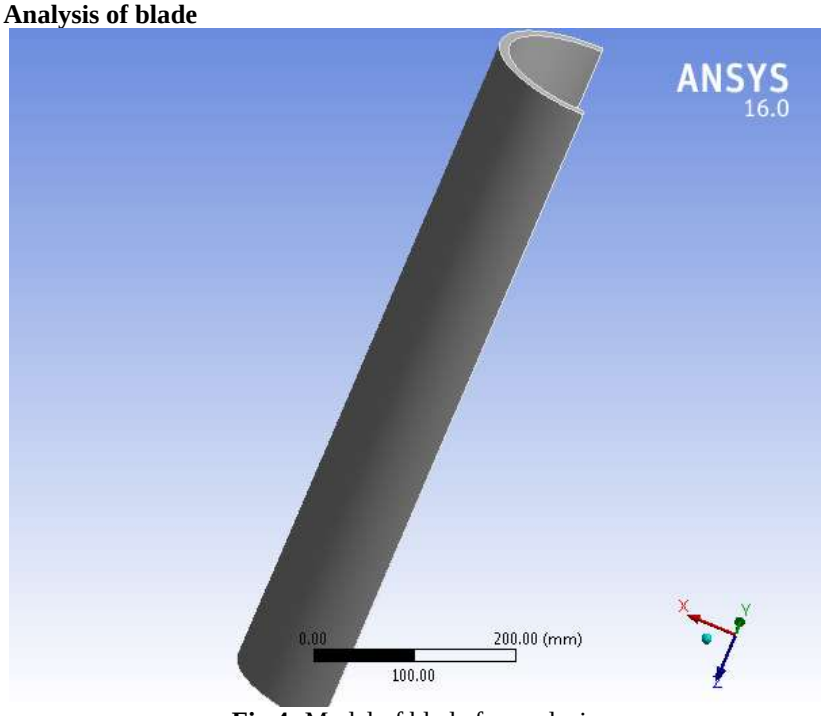

Fig 4: Model of blade for analysis

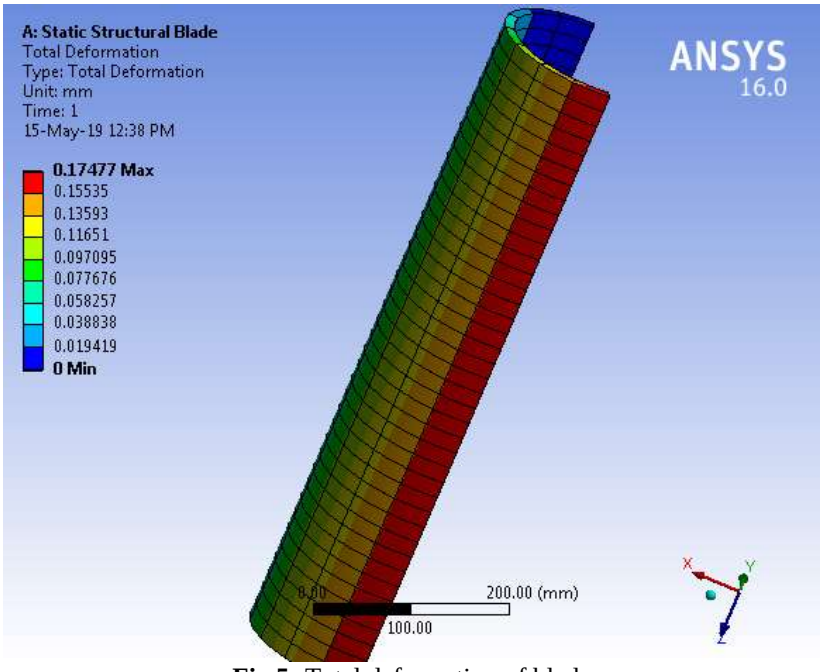

Fig 5: Total deformation of blade

V. Conclusion

Overall, vertical axis wind mill was a success. The wind mill that were designed harnessed enough air to rotate the stator at low & high wind speed while keeping the center of mass closer to base stability. The home of vertical axis wind mill would be in residential area & on express highways.

In residential area it can be mounted on the roof and be very efficient & practical. A home owner or society would be able to extract free clean energy thus experiencing a reduction in their utility cost & also contribute to the 'Green Energy' awareness that is increasingly gaining popularity. In future if magnet are used there will be reduction in the friction due to use of magnet more power can be generated. In terms of large scale power production, vertical axis wind turbines have not been known to be suitable for these applications. Due to the overall structure and complexity of the of the vertical axis wind turbine, to scale it up to a size where it could

provide the amount of power to satisfy an commercial/industrial park or feed into the grid would not be practical.

VAWM, it is the drag that acts on the blades & turns the rotor blades. Today, wind power is economically competitive compare to traditional energy because the cost of wind turbines is getting cheaper because of technology advancement & government incentives. It also create jobs & generates extra personal & tax income. Wind energy is also a renewable & pollution-free energy which can help us reduce the emission of greenhouse gases. We believe that wind energy can become an important asset to solve climate & global warming issues in the future.

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