The main goal of the project is to design a ¼ scale 3-bladed H-Type Vertical Axis Wind Turbine (VAWT) that can generate 1000 Watt of power. In the design process, the aerodynamic analysis, structural analysis and modal analysis are done. After designing the VAWT, a prototype is manufactured and tested.

Aerodynamic Design
For the aerodynamic design calculations, momentum based multi stream tube model is used.

Design Inputs
- Power: 1000 watt
- Diameter: 60 cm
- TSR: 4.5
- Solidity: 0.225
- Wind Speed: 10 m/s
- No. of blades: 3

Design Outputs
- Airfoil: NACA0018
- Height: 35 cm
- Chord: 4 cm

Transient calculations are kept running until the solution is converged.

2-D CFD analysis are performed to predict the output power and aerodynamic forces over the blades. Sliding mesh technique is used in transient calculations with 0.0001s and 0.0002s time steps. Mesh involves 500,000 nodes. These analyses are performed for NACA0018 and FX 63-137 airfoils with different wind speeds.

Cp-Time graph with 0.0001s time step

Picture of the manufactured VAWT

Modal Analysis

- 2-D CFD analysis of the designing VAWT is performed to calculate the power and force values.
- Sliding mesh technique is used.
- 0.0001s and 0.0002s time steps are tried. According to the results 0.0001s time step is unnecessarily small and causes waste of time.
- Aerodynamic forces over the airfoil blades are calculated and plotted. This force is used as input to the structural analysis of the turbine blades.
- All these analysis performed for NACA0018 and FX 63-137 airfoils with different wind speeds.
- In structural part, the aerodynamic force is used as an input. However, as determined the centrifugal forces dominate the aerodynamic forces.
- Maximum total deformation occurs on the blades. In order to prevent or minimize this deformation, blades produced by carbon fiber material.
- With modal analysis, the natural frequency of the system is calculated and kept away from the rotating frequency to prevent collision.
- A ¼ scale prototype is manufactured
- Wind Tunnel Test of the scaled model is done.

Conclusions