10kW (13m/s) 5m diameter carbon fibre blades for wind turbine

Abstract

A 10kW wind turbine blade set has been built for use with the 10 kW, 15ϕ Axial flux pancake generator, when attached the turbine is estimated to produce approx 4-5kW electrical power at 50% efficiency with 8-10kW of mechanical power driving the generator. The total cost of the turbine blades was AU$405 and the blades were constructed with typical “home-workshop” tools.

Keywords: Wind power, Wind turbine blade construction, 10kw wind turbine

LIST OF FIGURES

1. Constructing the interior of the wind turbine blades

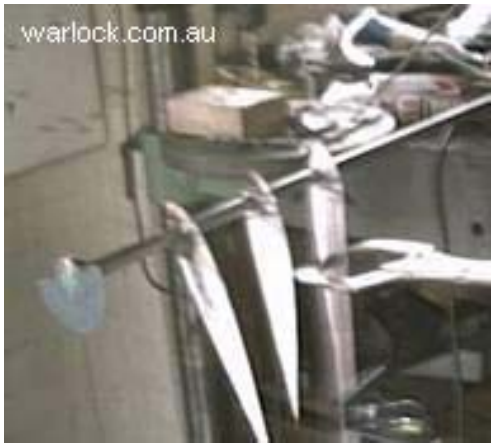

Figure 1. Steel blade core

The airfoil shapes were printed using a computer, the printouts were glued on 1mm sheet metal and cut out. The steel airfoils cut-outs were welded on steel tube, with the angle set by using a protractor against a plumb line.

Figure 2. Skeleton airfoil blade one

Figure 3. Skeleton airfoil blade two

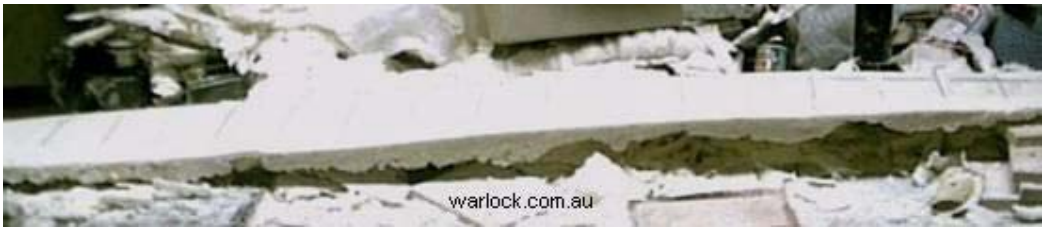

Figure 4. Skeleton filled with polyurethane foam

The skeleton was filled with expanding polyurethane foam (1kg Suprasec 5005, 1kg Daltolac GP33) and sanded into shape.

Figure 5. Polyurethane foam blade after sanding

2. Constructing the exterior of the wind turbine blades

Figure 6. Blade after being covered in chop strand matt fibreglass

The blade was coated in a layer of vinyl ester resin and one the resin had cured, 220g chop strand matt fibre glass was used to fibreglass the blades, this was does several times with sanding to ensure a smooth finish.

Figure 7. Blade after being covered in bi-axial glass cloth fibreglass

400g bi-axial glass cloth was wrapped around the blade and fibre glassed in place. It was lightly sanding before applying another layer of chop strand matt.

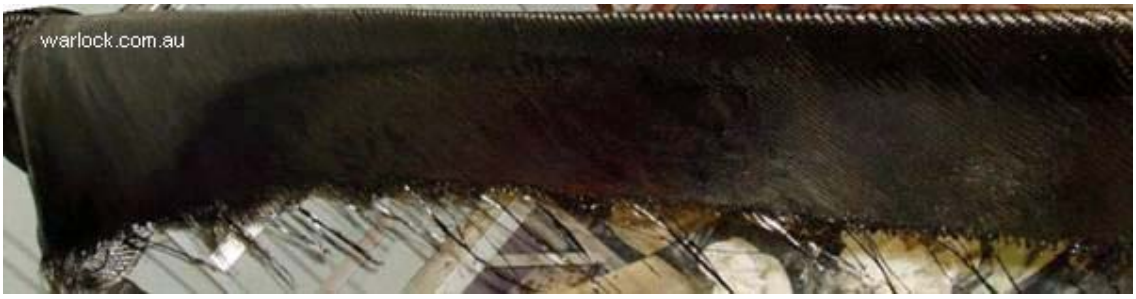

Figure 8. Blade after being covered in uni-directional carbon fibre

Chop strand matt was sanded into shape before applying the final layer of 197g uni-directional carbon fibre. The carbon fibre lightly sanded to form smooth flat blade

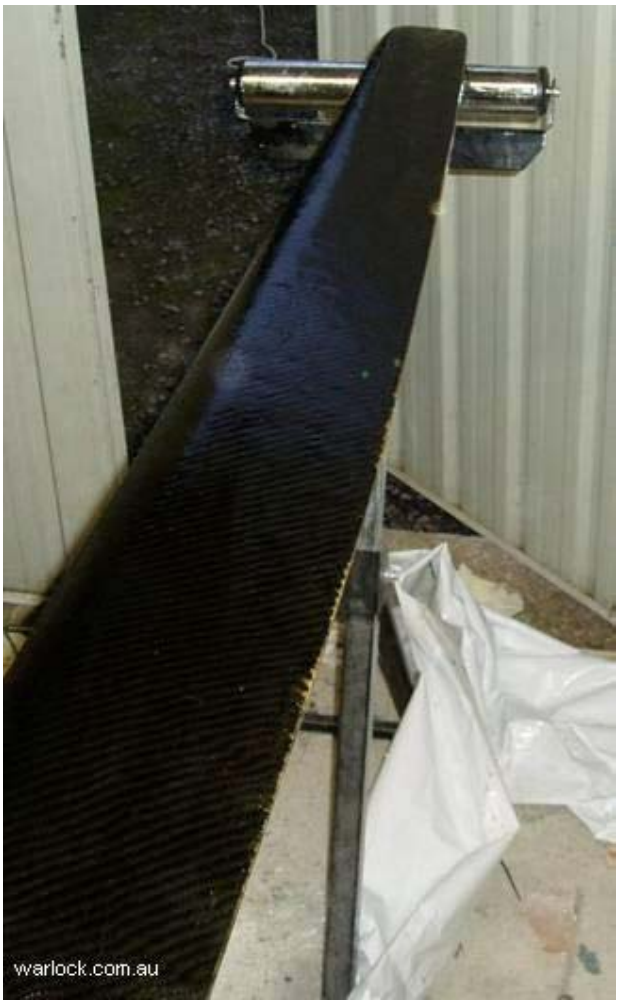

Figure 9. Blade after sanding the carbon fibre

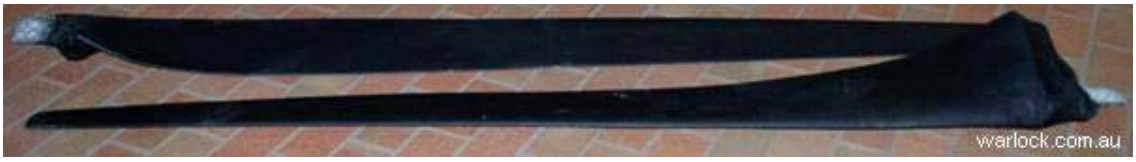

Figure 10. Completed 5m wind turbine blades

3. Calculated output of the wind turbine system

Output of system at maximum generator output (generator efficiency of 50%)

Wind speed = 13m/s
TSR = 9
Blade Efficiency = 0.4
Mechanical Power = 10,525.7 Watts
Rotational Speed = 446.9 RPM
Rotational Torque = 224.91 N.m

Running at a TSR of 9, the generator should output 2kW electrical power, requiring 4kW mechanical power

A TSR of 12.5 is a better match to the generator

TSR = 12.5
Blade Efficiency = 0.3
Mechanical Power = 7894.3 Watts
Rotational Speed = 620.7 RPM
Rotational Torque = 121.45 N.m

Running at a TSR of 12.5 the generator should output 4kW electrical power, requiring 8kW mechanical power

4. Total cost of the wind turbine blades

System cost (AUD)
Steel $25
Polyurethane $40
Matt, cloth, resin and initiator (MEKP) $220
Carbon fibre *(increased strength, not essential)* $120

Total cost $405

4. Equipment used

Arc welder
Grinder
Drill
Wood saw
Sand paper
Fibreglass rollers
Paint brushes

5. Conclusion

At a total cost of $1,278 including the generator, a wind turbine capable of producing 4-5kW electrical power makes a very cheap alternative for power production especially in remote areas.