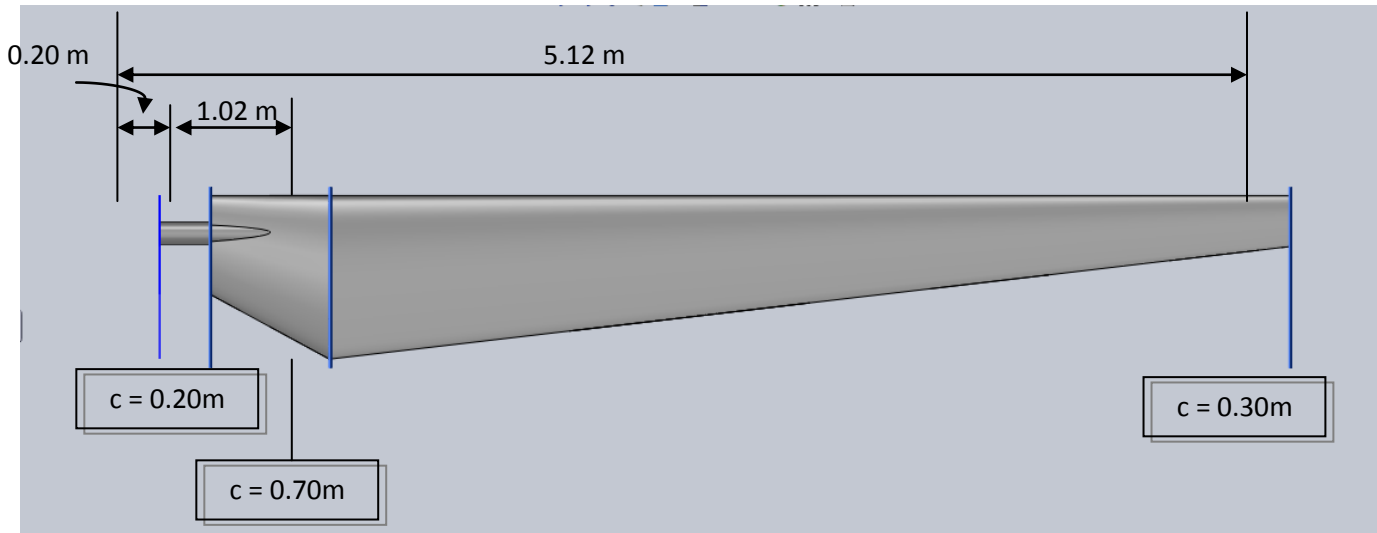


MEE556 Aeroelasticity Coursework

Introduction

You are asked to design a wind turbine blade for a 10kW three-bladed upwind horizontal axis wind turbine which will be located in Bangkok. The blade is to be constructed with GFRP skins with an inner supporting wing-box type structure whose shape has not yet been finalised. You must determine an appropriate cross-section shape for this structure.



Wind turbine blade and atmospheric properties

| | | |
|----------------------------|-----------------------------------|------------------------|
| Wind speed at design point | ($U_{\text{free stream}}$, m/s) | 8.5 |
| Tip speed ratio | (TSR) | 5 |
| Air density | (ρ , kg/m ³) | 1.145 |
| Dynamic viscosity | (μ , kg/m.s) | 1.895×10^{-5} |

Assumptions

1. Only aerodynamic forces are acting on the wind turbine blade sections (elements)
2. All aerodynamic forces are acting at the aerodynamic centre which is located at the quarter-chord position
3. The blade planform is designed in such a way that the locus of aerodynamic centres forms a straight line along the y-axis.
4. The hub is assumed to be rigid and the blade root may be assumed to be mounted on a fixed support

Task

1. Choose an aerofoil profile for the wind turbine blade and determine the appropriate twist angle variation
2. Determine the following wind turbine blade structural properties
 - a) Flapwise bending flexural rigidity distribution, $EI(y)$, which conforms to the design standard where the tip deflection must not exceed $R/300$
 - b) Torsional rigidity distribution, $GJ(y)$ where the maximum twist is below 1degree

Hint

1. The wind turbine blade has a variable cross-sectional areas, hence the flexural rigidity and torsional rigidity must vary along its length too, ie. EI and GJ are functions of y
2. The most aerodynamically efficient situation is the one where the aerofoil generates the maximum lift and a minimum drag. Use this information to determine the twist profile $\theta(y)$ of your blade.

