1. WIND TYPE

1.1. QuasiStatic

The QuasiStatic solver defines the thrust and generated power developed over the turbine rotor by using a look-up table. The look up table relates the wind velocity perceived by the rotor with the correspondent rotor Ct (thrust coefficient) and Cp (power coefficient) coefficients.

The velocity perceived by the rotor takes into account the incoming wind speed and the velocity of the rotor movement.

1.1.1. Constant

The QuasiStatic Constant option defines the incoming wind speed as a 3-components vector defined in a Cartesian reference system with origin in the rotor center, the x-axis perpendicular to the turbine rotor, and the z-axis parallel to the tower and pointing upward.

1.1.2. Uniform

The QuasiStatic Uniform option generates an incoming wind speed field variable in time with a constant pattern in space. a time series that defines the fluctuation of a velocity 3-components vector. The series is defined by the user in a table which relates arbitrary time points with a velocity 3-components vector. The vector is defined in a Cartesian reference with origin in the rotor center, the x-axis perpendicular to the turbine rotor and the z-axis parallel to the tower and pointing upward. Values between the user defines setpoints are obtained by linear interpolation.

1.2. Dynamic

The Dynamic solver is based in an unsteady BEM model [1]. Such model is based on the momentum balance of the mass of air passing throughout the rotor and resolve the velocity triangle in each node of the discretized rotor blades. The aerodynamic forces calculated in each node are integrated to find the forces and moments developed over the entire rotor.

In order to simulate the turbine controller operations, the BEM model is linked with the Basic DTU Wind Energy controller [2], which has been tuned to avoid negative damping effects.

1.2.1. Constant

The Dynamic Constant option creates a steady incoming wind speed over the rotor. Such velocity field is set by defining a 3-components vector at the rotor center position. The vector is defined in a Cartesian reference system with axes parallel to the inertial reference frame, and with origin at the rotor center. Thus, the relative orientation between the turbine rotor and the wind speed direction changes with rotor movements. The distribution of the incoming wind velocity in space is defined by a wind profile characterized by the exponential law with exponent equal to 0.14.

1.2.2. Uniform

The Dynamic Uniform option sets an incoming wind velocity field variable in time with a constant pattern in space. Such information is provided by the user in a table which relates arbitrary time points with a velocity 3-components vector. The vector is defined in a Cartesian reference system with axes parallel to the inertial reference frame, and with origin at the rotor center. Thus, the relative orientation between the turbine rotor and the wind speed direction changes with rotor movements. The distribution of the incoming wind velocity in space is defined by a wind profile characterized by the exponential law with exponent equal to 0.14.

1.2.3. 3D full field

The Dynamic 3D full field option generate an incoming wind velocity field variable in time and space. The wind dataset is built with TurbSim [3], a stochastic, full-field, turbulent-wind simulator developed at NREL by using a Kaimal turbulence model.

The user provides the mean wind velocity, the IEC 61400 1 turbulent class and the wind main direction.

2. MOORING TYPE

2.1. Dynamic method

Based on the finite element method, considers the effects of the line velocity and acceleration on the tension at the fairlead.

2.2. QuasiStatic method

Based on the catenary line analytic solution, neglects the effects of the line velocity and acceleration on the tension at the fairlead, so it is faster than the dynamic method.

REFERENCES

[1]   Hansen, M. O. (2015). *Aerodynamics of wind turbines.* Routledge.

[2]   Hansen, M. H., & Henriksen, L. C. (2013). *Basic DTU wind energy controller*.

[3]   Jonkman, B. J., & Buhl Jr, M. L. (2006). *TurbSim user's guide (No. NREL/TP-500-39797)*. National Renewable Energy Lab. (NREL), Golden, CO (United States).