The OneWind® Modelica Library for Wind Turbine Simulation with Flexible Structure — Modal Reduction Method in Modelica

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The OneWind® Modelica Library[1] [1] for coupled wind turbine loads calculation developed at Fraunhofer IWES uses a structural element based on a modal reduction method to model the motion and deformation of flexible wind turbine rotor blades and tower. The degrees of freedom (DOF) are rigid body motions and modal DOF. The `ModalElement` model allows the simulation of coupling effects like bend-twist coupling in wind turbine rotor blades and the structural behavior is dependent on the selected eigenmodes. This paper gives an overview about the Modelica implementation of the theory of modal elements, the advantages over other methods (finite-elements), how the `ModalElement` model is included into the OneWind® Modelica Library, and how it is used for load calculation.

The objective is to achieve the same accuracy as the finite element method (see Figure 1) with less computational time. This is a requirement for a wind turbine load calculation with a large number of load cases which are necessary for fatigue analysis.

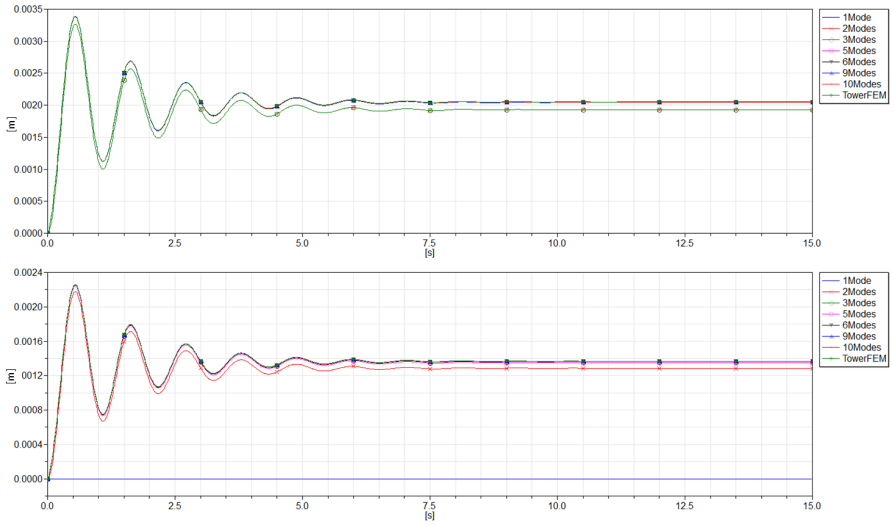

Figure 1: Deflection of `ModalElement` model based wind turbine tower top: upper plot shows downwind displacement, lower plot shows side-to-side displacement

References

[1] Strobel M., Vorpahl R., Hillmann C., Gu X., Zuga A., Wihlfahrt U. The OnWind Modelica Library for offshore wind turbines – Implementation and first results. In: Proceedings of the 8th International Modelica Conference 2011, Dresden, Germany, Modelica Association, pp. 603 - 609, 20-22 March 2011.

[1] Version 1.0 for onshore wind turbine load calculation was released and is now available under dual license model. For further information contact: info@onewind.de