Development of ’Dynamics for Design’ Procedure of Wind Turbine Drivetrain: Multibody Based Approach

Mohamed Saleh
Benha Faculty of Engineering
Benha University, 13512
Benha, Egypt

Ayman Nada / Ahmed El-Betar / Ahmed El-Assal
Benha Faculty of Engineering
Benha University, 13512
Benha, Egypt

Dynamics for Design (DFD) is the integration of recent advances in system dynamics including nonlinearities, vibration analysis, and multibody systems with current design methodologies. The goal of integrating these subjects in one procedure is to obtain efficient design cycle in terms of improved system reliability, and consistent behavior across operating environments. In the other hand, the rapid growth of wind energy technology has ensured the demand for advanced engineering methods to improve wind turbine design. The design optimization of such turbines and their subsystems will make future products more attractive compared with fossil and nuclear power plants.

This paper proposed a design procedure for one of these subsystems, which is the Wind Turbine Drive Train (WTDT). The design of the WTDT is based on the load assumptions and can be considered as the most important component for increasing the efficiency of energy generation. In industry, these loads are supplemented by expert assumptions and are extrapolated by static manipulations to calculate local load for the design of transmission elements, e.g. gears, bearings, and shafts. In contrary, in this work, the multibody system (MBS) approach is used to estimate the static as well as dynamic loads based on the Lagrange multipliers. Lagrange multipliers are numerical parameters associated with the holonomic and non-holonomic constraints assigned for the drivetrain model. The computational manipulations of kinematic stabilization, mapping the generalized forces into Cartesian respective, and implementation of velocity-based constrains into quadratic terms are carried out and the corresponding sub-routines are constructed.

Based on the dynamic model and the obtained forces, the design process of an epicyclic gear train is applied with trade-offs optimization in terms of gearing parameters. Numerical example of one-stage transmission is presented and the comparison with MSC-ADAMS software shows an excellent convergence.

Keywords(optional): Multibody Dynamics, Wind turbine drivetrain, Dynamics for Design

References(optional)

[1] Mohamed Sh.Saleh, ”Design of wind turbines drive train based on dynamic lagrange multipliers”, Master thesis, Benha University, 2015

[2] Shabana, Ahmed A., 2013, Dynamics of Multibody Systems. 4th ed., Cambridge University Press., Cambridge.

[3] Nada, A. A., Hussein, B. A., Megahed,S.M., Shabana A.A., 2010. ”Use of the floating frame of reference formulation in large deformation analysis: experimental and numerical validation”. Proceedings of the Institution of Mechanical Engineers, Part K: Journal of Multi-body Dynamic 224, 45-58.