FINITE ELEMENT MODELING AND NONDESTRUCTIVE MAGNETIC FIELD EVALUATION OF WIND TURBINE DRIVE TRAINS

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BACKGROUND

Wind Turbine Drive Trains

- Mechanical Component
  - Gearbox
  - Bearings
  - Rotating Shaft
- Electrical Component
  - Electric Generator

CHALLENGES AND MOTIVATION

- Dynamic drive train components – more susceptible to faults.
- Electromagnetic and electromechanical coupling among components.
- Individual modeling of components done by current FEA techniques.
- Coupling effects are neglected, yielding incomplete or incorrect approximations for modal analysis, turbine designs, etc.

OBJECTIVES

- Development of a unique co-simulation platform for integration of both mechanical and electrical components of the drive train.
- Conducting 3 case studies to analyze coupling effects by performing non-destructive magnetic field evaluations.
  - Case study I: Faults on mechanical component.
  - Case study II: Faults on electrical component.
  - Case study III: Faults on both the components.
- Demonstrating the effect of components' parameter change on the magnetic field distribution of the electric generator.

METHODOLOGY

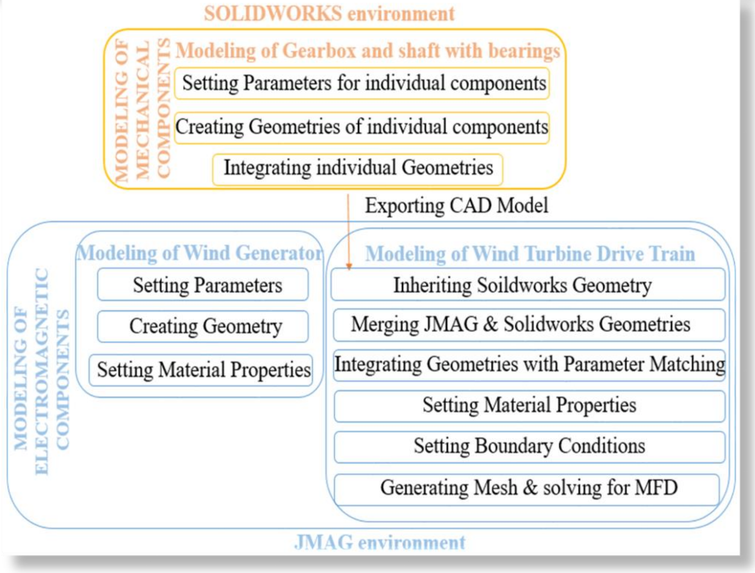

Fig. 1. Flowchart for construction of parametric FEA model of the Wind Turbine Drive Train through Co-Simulation.

KEY FINDINGS

- Mesh generation & magnetic transient analyses successfully conducted for the entire drive train.

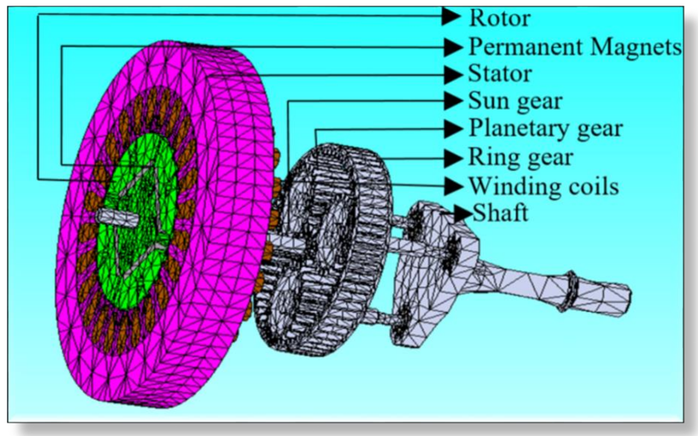

Fig. 2. Mesh generation of the Wind Turbine Drive Train for FEA

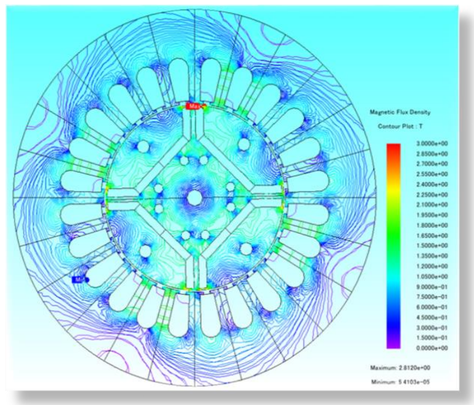

Fig. 3. Magnetic field evaluation of Wind Turbine Drive Train

- Three case studies were conducted by introducing faults on various components and analyzed by comparing values of magnetic field strength.

TABLE I: TABULATION OF AVERAGE VALUES OF CROSS-SECTIONAL MAGNETIC FIELD STRENGTH FOR VARIOUS CASES

CASES	Average values of the cross-sectional Magnetic Field Strength (A/m)
Healthy case	272.732
Case study I	235.553
Case study II	159.165
Case study III	152.055

DISCUSSION

- Significant changes are observed on the magnetic field distribution of the generator for each of the 3 case studies.
- Since the components are coupled, any change in the characteristics of any one of these components alters the common magnetic field distribution.
- The comparison study indicates that the electrical and mechanical components of the drive train are electromagnetically coupled.

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