Analysis of the IAS as a condition monitoring tool by means of a simplified dynamic model of a wind turbine shaft line

Jose L. Gomez[1, 2], Adeline Bourdon[1], Hugo André[2], Didier Rémond[1]

[1]Université de Lyon, CNRS, UMR5259, INSA-Lyon, LaMCoS F-69621, France
(jose-luis.gomez-chirinos,adeline.bourdon,didier.remond)[at]insa-lyon.fr
[2]Maia-Eolis, Tour de Lille, Boulevard de Turin, Lille, 59000, France
(jlgomez,handre)[at]maiaeolis.fr

Introduction

Since a decade, Instantaneous Angular Speed (IAS) has been shown to be an alternative signal to detect bearing faults in geared systems. Detection of the presence of bearing faults in rotating systems requires, among other things, a good understanding of the transfer way between the defect and its manifestation in the measured signal. This step is mainly performed by the development of numerical models which have to describe the couplings between the defects and the rest of the device.

To the authors' knowledge, the majority of the models in the literature are lump parameter models, with no regard between the dynamic of the bearing and the rotational degree of freedom of the shaft. The influence that the dynamic of a faulted bearing has over the rotating shaft leading to IAS variations has been presented on a previous work. This influence has been introduced by means of a roller bearing model which dynamics modified by the defect, introduces torque perturbations to the shaft. Comparisons made between measurements taken with optical encoders over a wind turbine shaft and results from the model has shown the potential of the approach.

The aim of this paper is to couple the faulted bearing model to a multiple gear stage wind turbine transmission with the objective of analyzing the impact of the transfer way imposed by the gear interaction. The propagation of the perturbation from the point of view of the IAS analysis and the influence of the gears interaction are the subjects of study

Approach

The model is built with a finite element approach and is suitable for the test of non-stationary simulations. The transition from the stationary to non-stationary operating condition operation is easy when using angular approaches by expressing dynamics in angle domain, by managing simulation steps through angular sampling and by taking into account the rotating degrees of freedom of the device of interest.

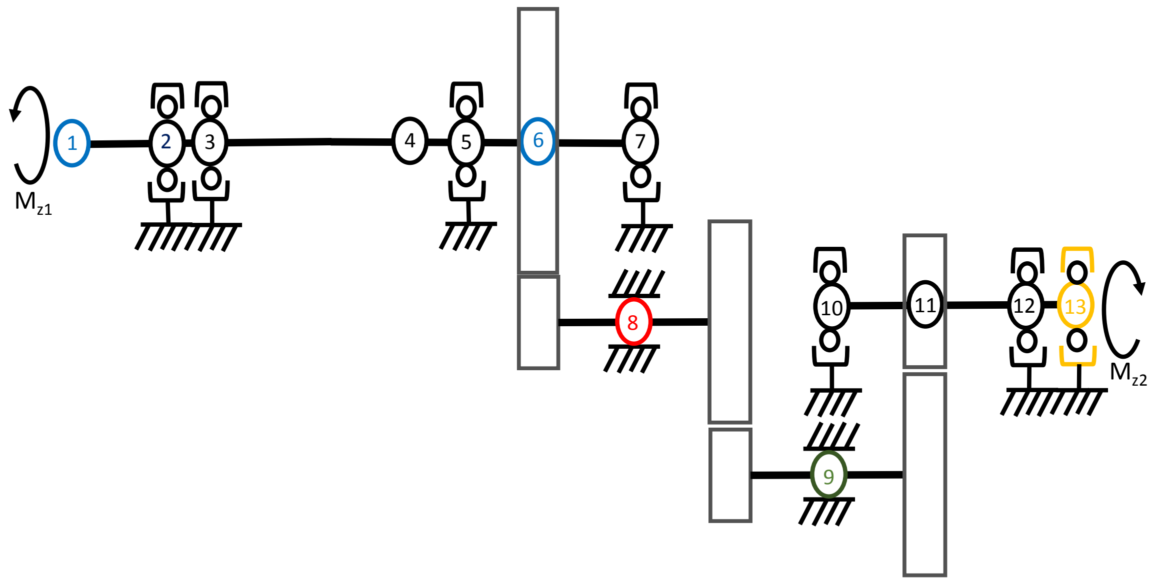

Figure. Schema of the model showing the finite element nodes

The gear coupling is performed by a classic approach where a linking element, with the possibility of applying variable stiffness to the teeth, produces the transmission ratio of each stage. Solving of equations is performed on the angular domain with built in Matlab's Runge-Kutta solvers.

Main body of abstract

Different simulations are performed with stationary and non-stationary conditions by adjusting the input torque over the slow shaft of the machine. The analysis of the IAS is performed in the angular domain as well as in the frequency domain. Different tools are used for the frequency domain analysis which led us to better understand the phenomena.

Conclusions

First results show bearing faults are detectable in different locations of the geared system by the measurement of the IAS. Even if experimental validation have not been yet performed, numerical results appear very promising to deepen the understanding of the IAS variation phenomena.

Learning Objectives

- Modelling the IAS phenomena in presence of bearings and gear stages
- Improve the understanding of the IAS as a monitoring condition tool
- Application and observation of the response of different frequency domain tools to the IAS signal.