

Wind Turbine gearbox remaining lifetime prediction and early failure detection

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Summary

Wind farm maintenance is exceptionally challenging, the actual lifetime is shorter than the expected 20 years, with the main issue being the gearbox. Wind farm owners need to be able to predict the Remaining Useful Lifetime (RUL) of their gearboxes, in order to safeguard functional performance, optimize maintenance planning and reduce cost.

Winergy and **Siemens PLM Software** have developed an approach to estimate the RUL of a complete wind park by combining the historical wind data, a Digital Twin of the wind turbine and material properties of the rotating gearbox components:

1. Wind Turbine gearbox remaining lifetime

1.1 Used approach

Three necessary steps are required in the prediction of the RUL:

- Complete knowledge of the wind loads the turbine has experienced
- Simcenter Samcef model that is able to link wind loads to gearbox component loads (forces, torques)
- Material knowledge of the components to translate loads into damage

1.2 Available data

To complete the required steps for the RUL calculation, the following data was used:

- 4 years of SCADA data (Supervisory Control And Data Acquisition)
- Gearbox manufacturers data of the gearbox (design values)
- Operational (high sampled) and modal data of the turbine. Acquired by an extensive test campaign.

2. Project Results

2.1 Definition of wind load cases

To reduce the amount of required simulations, the SCADA data was analysed and reduced to discrete wind load conditions.

2.2 Selection of brake events

The occurrence of transient events (e.g. brake events) will have an effect on the RUL of the turbine. The most severe and most occurring events were selected.

2.3 Digital Twin correlation

The Simcenter Samcef model is correlated and updated based on Modes and Operational Response.

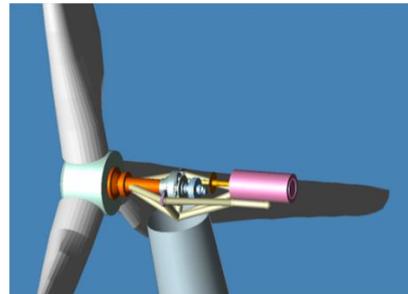


Fig. 1: Simcenter Samcef model

2.4 Load calculations

Using the Simcenter Samcef model, the loads on the gearbox components can be calculated for all the defined wind load conditions (stationary and transient).

2.5 Remaining lifetime calculation

Winergy has, as a manufacturer of the gearbox, insights in the material properties of all rotating gearbox components. By using these insights, the mechanical loading of a rotating component can be translated into 'component damage', leading to RUL estimation for all rotating gearbox components.

Winergy

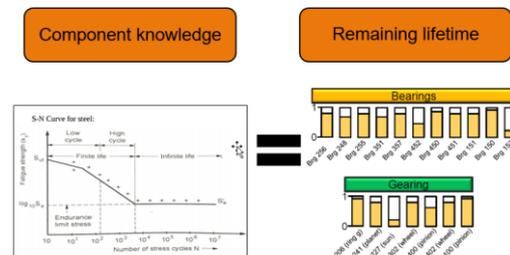


Fig. 2: Using component knowledge to translate mechanical load into component damage