Accuracy of load assessments based on modelled turbulence

The German example

Lasse Svenningsen¹ (ls@emd.dk), Carolin Schmitt² and Gudrun Potzka³
1) EMD International A/S, 2) Juwi AG and 3) EMD Deutschland GbR

Abstract

This work studies the accuracy of wind turbine fatigue load assessments based on modelled ambient turbulence intensity (TI) for typical German sites. The results are important as wind measurements are not commonly installed when developing a wind farm in Germany or Denmark. The wind model is calibrated with production of neighbouring wind farms, but measured TI is used directly in site suitability assessments according to e.g. IEC61400-1 [1].

Approach

Fatigue loads are estimated using the measured wind climate for 23 masts in non-complex terrain. Results are compared to load estimates based on the same wind climate, but with the measured TI replaced by modelled TI.

Work flow of the approach:

- Fatigue loads are estimated using the measured wind climate for 23 masts in non-complex terrain. Results are compared to load estimates based on the same wind climate, but with the measured TI replaced by modelled TI.

Turbulence Models and Data

TI is calculated using two different micro scale models: WEng and WAsP-CFD. Additional assumptions are needed as these models predict mean TI, but [1] requires the 90th percentile (TI90, +1.28TI0). Two assumptions are studied:

1. “COV=0.2” proposed in windPRO
2. “WAT/NTM” proposed in WAT

Model assumptions in (1) and (2):

1. TI90 = TI_model + 1.28TI0
2. TI90 = 0.9TI_model + 1.18TI0

Example of (1) and (2) for TI_model=0.12:

- TI90 (“WAT/NTM”)
- TI90 (“COV=0.2”)

Results

The 23 masts included in this study show consistent and on average unbiased results for WAsP-CFD and WEng using the “COV=0.2” assumption.

Results for WEng+”WAT/NTM” show a significant positive bias, particularly for tower loads, which are more sensitive to high TI at low wind speeds.

Results normalized to loads using mast TI:

- WAsP-CFD (“COV=0.2”)
- WEng (“COV=0.2”)
- WEng (“WAT/NTM”)

Conclusions

WEng and WAsP-CFD load results are comparably accurate using “COV=0.2”.

Load assessments using “COV=0.2” are unbiased (mean bias < 2-3%).

Load assessments using “COV=0.2” are most accurate (SD bias = 5-6%).

Load assessments for WEng with “WAT/NTM” have a significant positive bias.

References

3. windPRO 3.0 LOADS manual p 36 [http://help.emd.dk/knowledgebase/content/WindPRO3.05/UI_en/WinPRO/docs/01-LOADS.pdf]
4. DTU WAT 4.1, Help/Introduction/Modelling with WAT/Ambient turbulence models/Method 1