

Wind and soil model influences on the uncertainty in fatigue of monopile supported wind turbines

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Model uncertainties in design

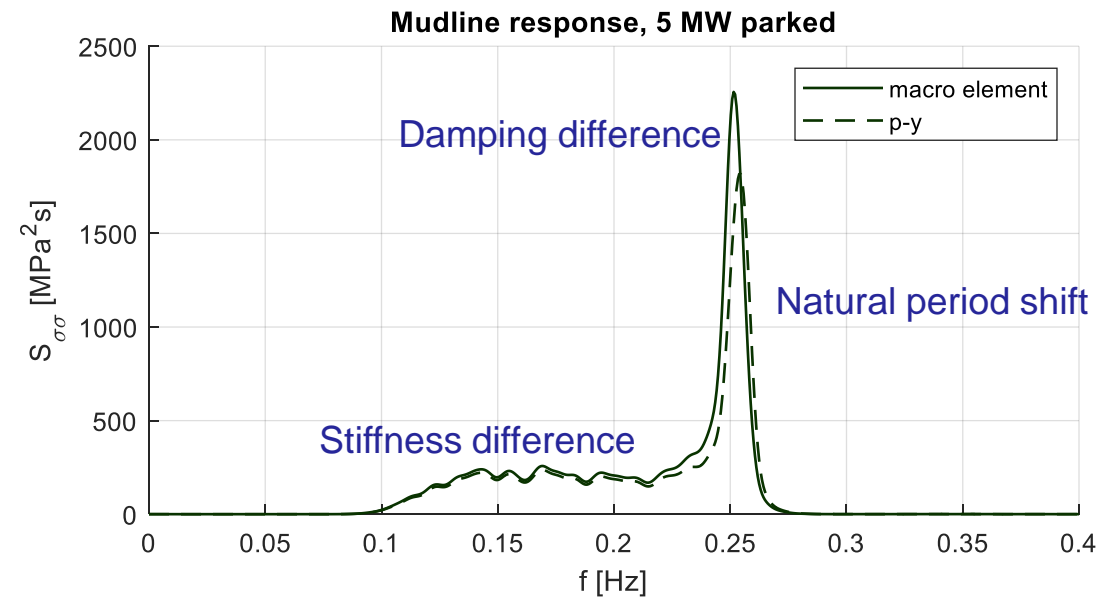
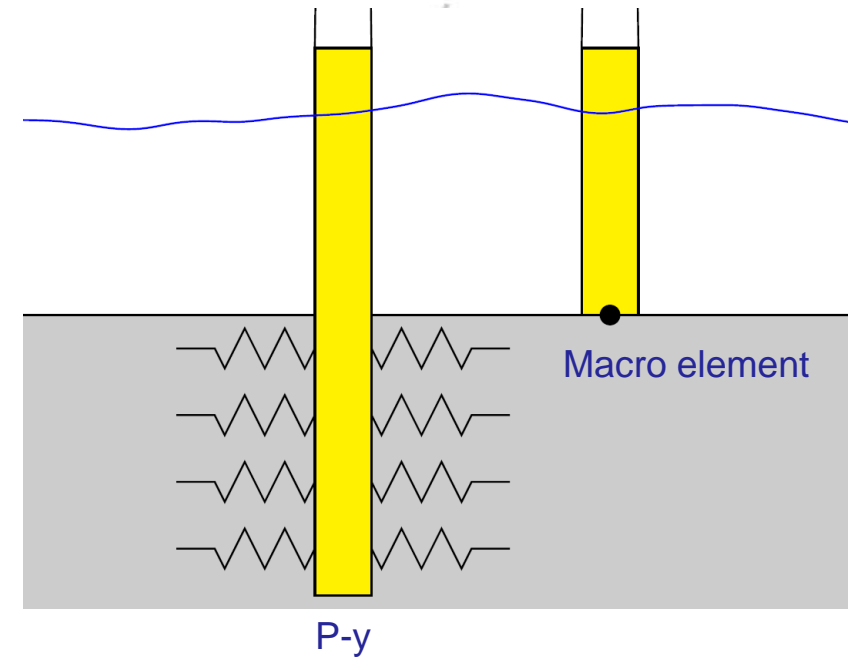
- Multiple models typically available for design
- Accuracy hard to determine
- Effects of larger turbines

- Here:
- Soil macro element vs. p-y curves
- Kaimal wind spectrum vs. Mann turbulence model
- NREL 5 MW, DTU 10 MW and IEA 15 MW turbines
- Fatigue damage

Soil models

P-y	Macro element
Non-linear elastic	Non-linear, plastic
Rayleigh damping	Hysteretic damping

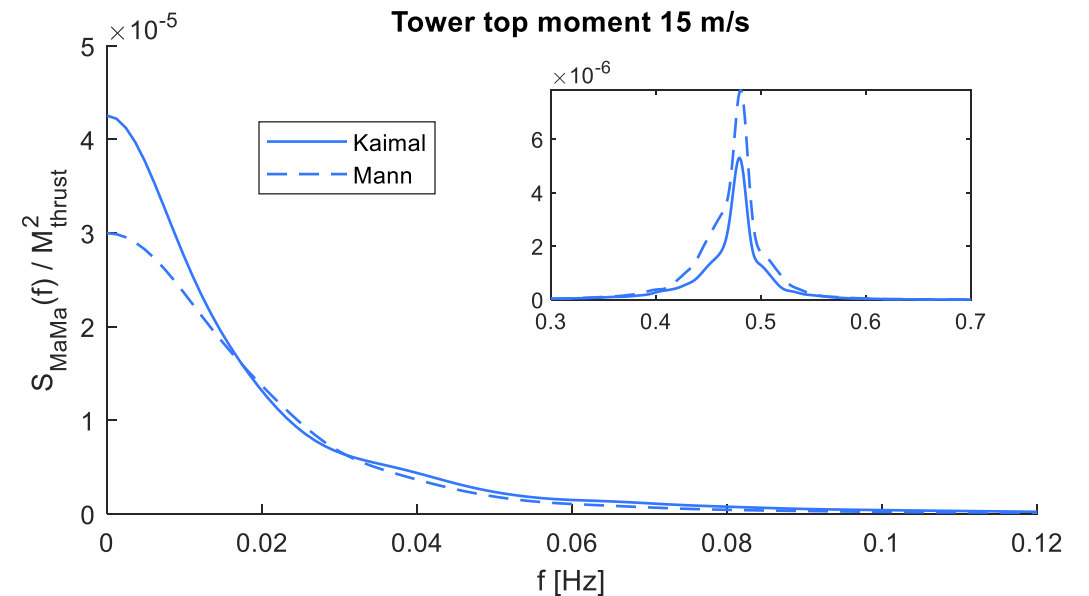
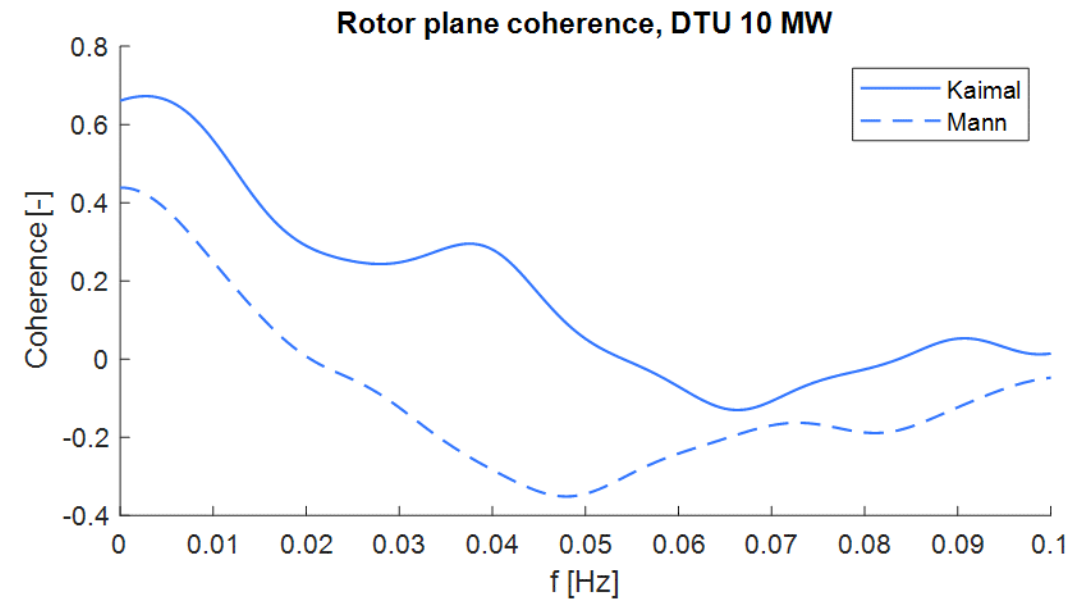
- Effects of differences:
 - Stiffness
 - Natural period
 - Damping



Wind turbulence models

Kaimal	Mann
Kaimal spectrum	Fitted to Kaimal spectrum
Exponential coherence	Velocity tensor

- Effects of differences:
 - LF: Kaimal response highest
 - HF: Mann response highest



Long term fatigue effects

- Turbines size:
 - Differences in soil models reduce with larger turbines
- Soil:
 - Stiffness and damping variations model dependent
- Wind turbulence
 - Frequency content of response determines