FACULTY OF ENGINEERING AND ARCHITECTURE

SOETE LABORATORY – EMSME (EA08)

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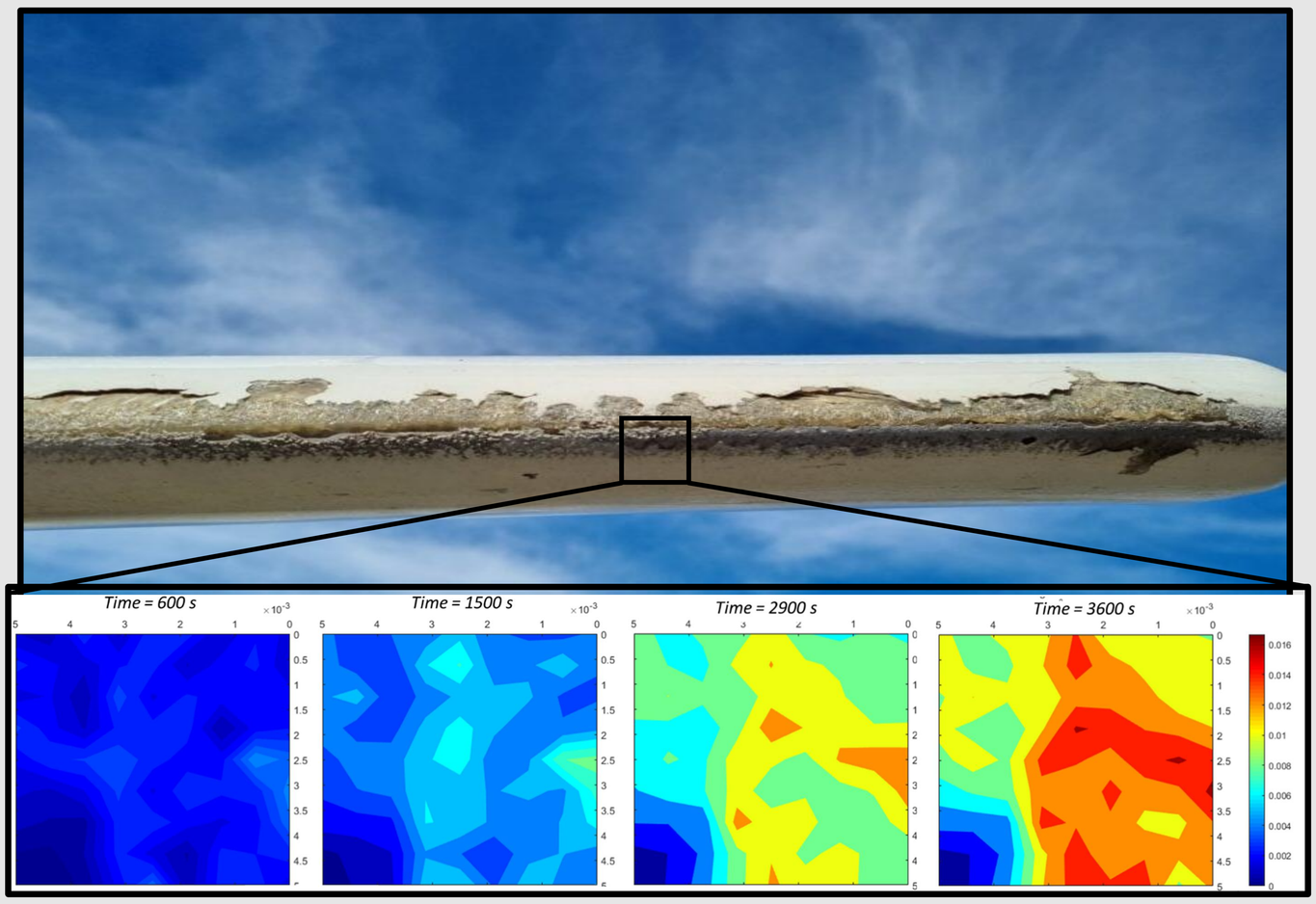
CFD-FSI MODELLING OF WIND TURBINE BLADE LEADING EDGE EROSION



PROBLEM STATEMENT

Wind turbine blade leading edge erosion (WTB-LEE) - a critical flaw of wind turbine technology.

WTB-LEE reduces aerodynamic performance, annual energy production, and turbine blade life.

Severe WTB-LEE can reduce annual energy production by up to 25% [1] .

Challenges to development of offshore wind:

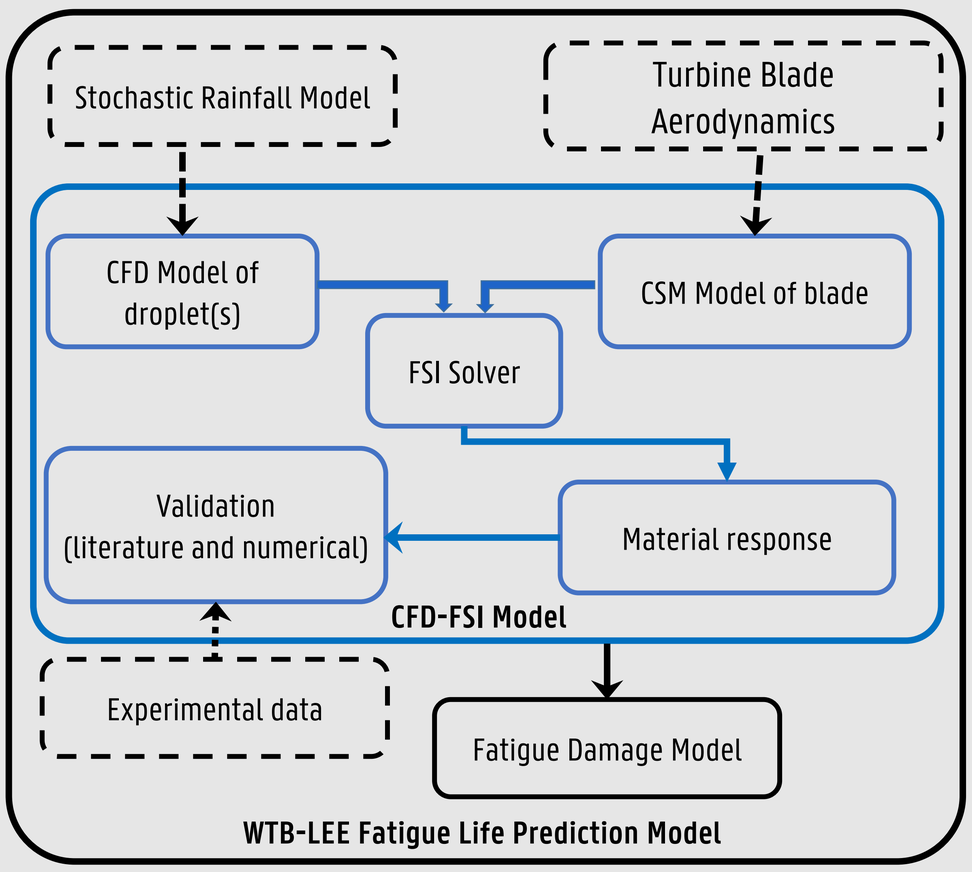
- Higher incidence of severe weather events like storms and cyclones.
- Blade speed increasing with blade length as offshore turbine sizes increase.
- Reduced accessibility for erosion monitoring and maintenance.

OBJECTIVES

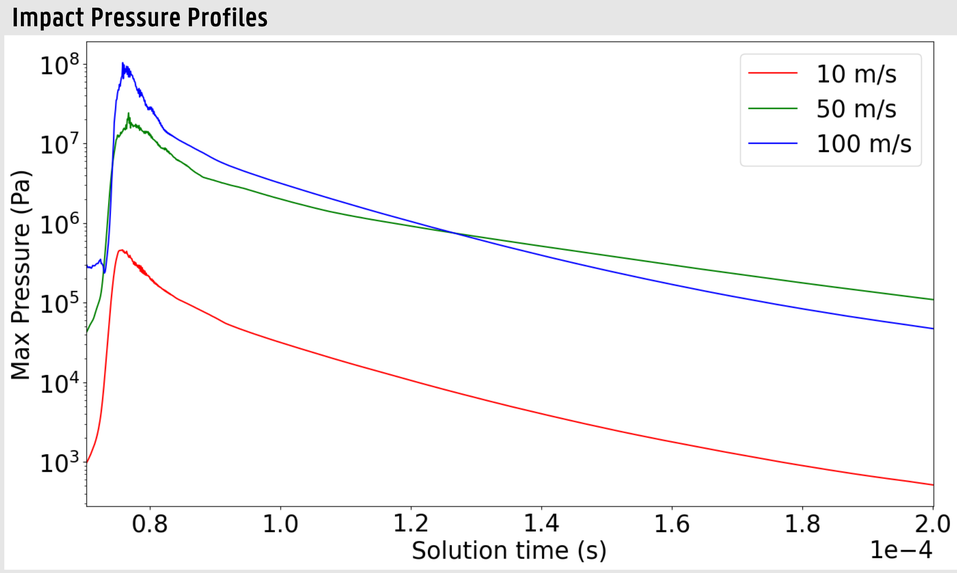
Numerical modelling of rain droplet induced erosion.

- In-depth understanding of droplet impact dynamics.
- Fluid-solid interaction model to correlate droplet impacts to solid stresses.
- Predicting material removal rates corresponding to different rainfall scenarios.

METHODOLOGY



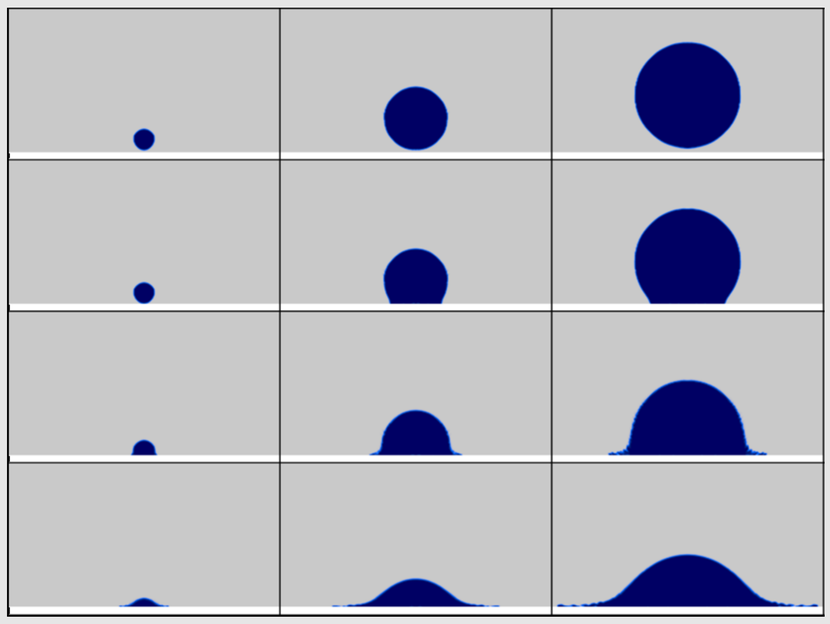
Impact Pressure Profiles



Maximum pressure experienced by solid body during single droplet impact.

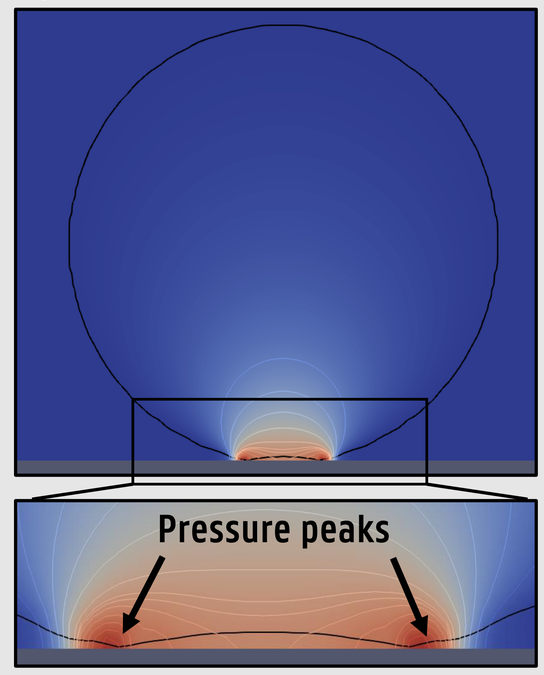
CURRENT PROGRESS

Single Droplet Impact



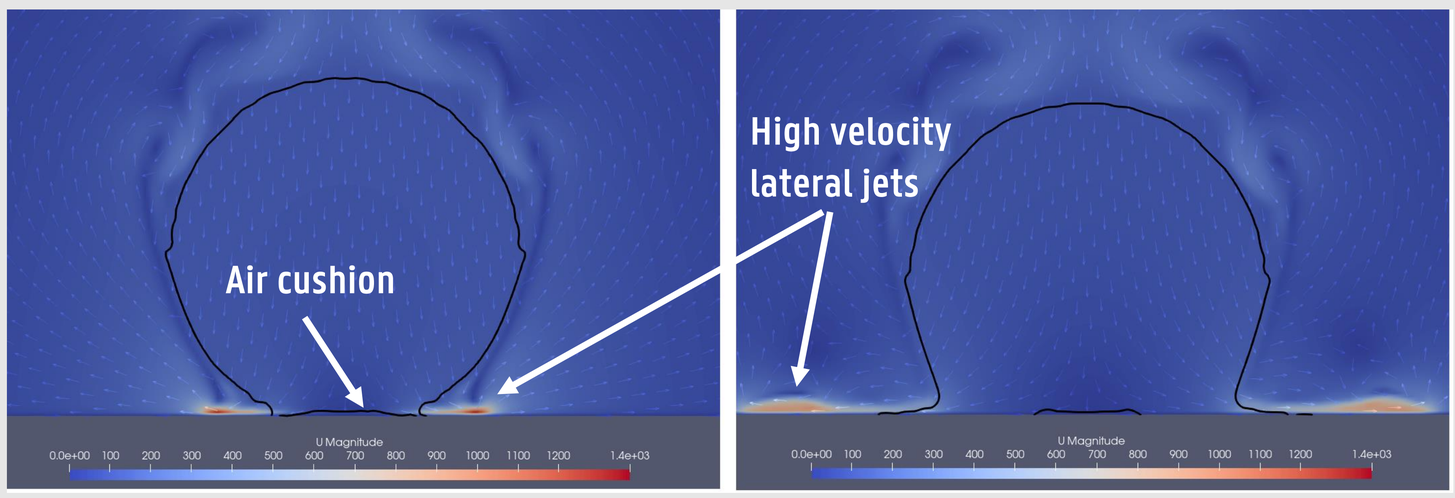
Progression of single droplet impact. Droplet diameter 1mm, 3mm, and 5 mm.

Impact Features – Pressure contours



Pressure field during single droplet impact.

Impact Features – Velocity contours



Velocity field during single droplet impact.

REFERENCES

1. Sareen, A., Sapre, C. A., & Selig, M. S. (2014). Effects of leading edge erosion on wind turbine blade performance. Wind energy, 17(10), 1531-1542.
2. Ilsted Bech, J (DTU Wind & Energy Systems). "Polytech proves lifetime of product with Rain Erosion Tester from R&D Test Systems " [webpage], https://www.rd-as.com/cases/polytech-proves-lifetime-of-product-with-rain-erosion-tester-from-rd-test-systems/ (Accessed – 01/09/2023)
3. Doagou-Rad, S., Mishnaevsky Jr, L., & Bech, J. I. (2020). Leading edge erosion of wind turbine blades: Multiaxial critical plane fatigue model of coating degradation under random liquid impacts. Wind Energy, 23(8), 1752-1766.

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