

CFD study on droplet impact pressure estimation to predict the rain induced erosion of wind turbine blades

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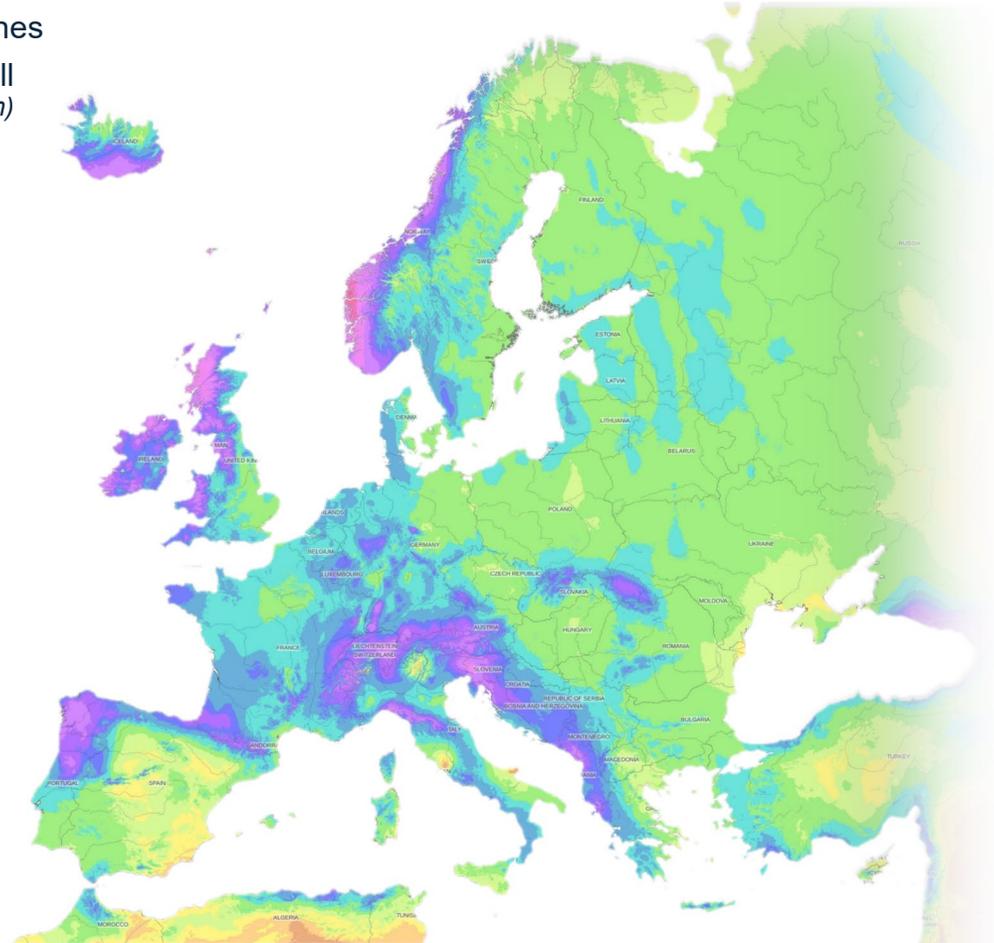
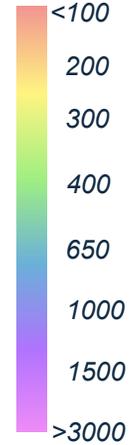
CONTENT

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Background
- 2** CFD analysis
Droplet impact pressure
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Different droplet sizes
- 4** Conclusion
Summary | Acknowledgement

1 Rain erosion Background

■ Wind turbines

Annual Rainfall
(mm)



Rain Erosion;

- ↓ *Life span*
- ↓ *A E P*
- ↑ *O & M*



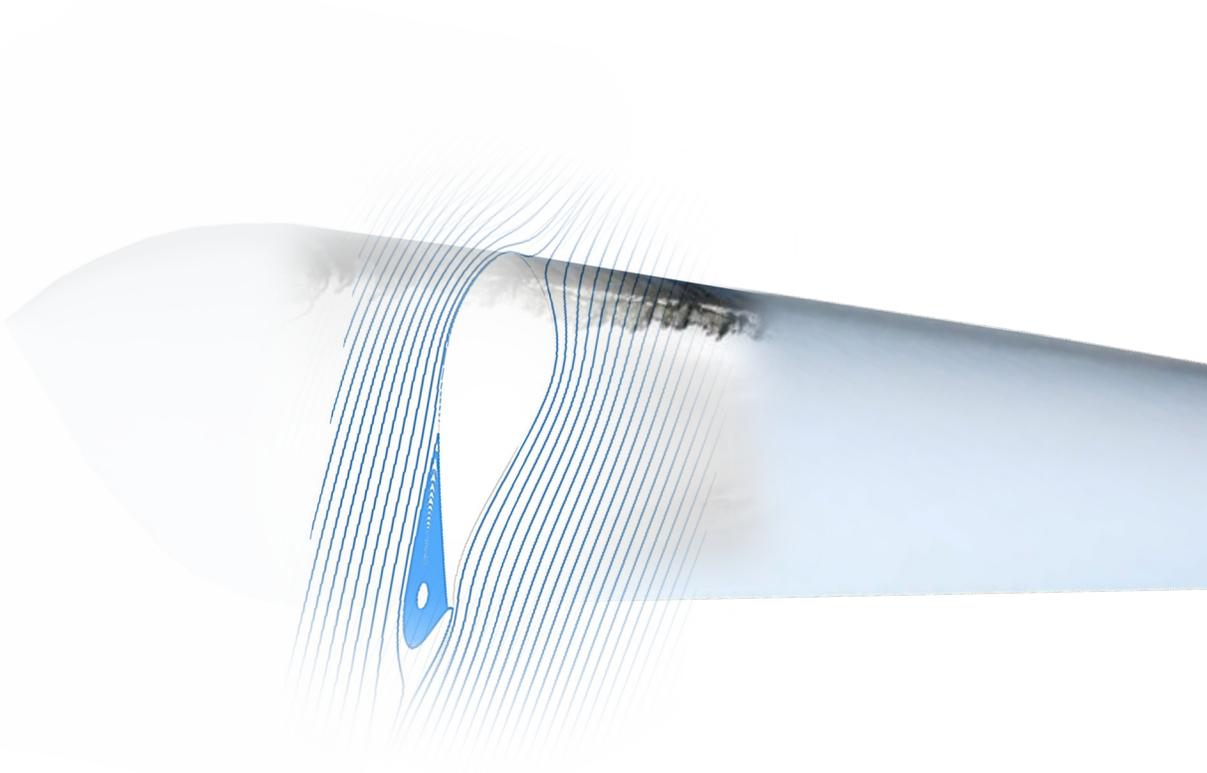
Erosion Studies;
Repair frequency
New coatings

References:

Wind turbine map: <https://landgeist.com/2022/02/25/wind-turbines-in-europe/>

Annual rainfall map: https://www.reddit.com/r/MapPorn/comments/a4o66s/europe_average_yearly_precipitation_link_to/

1 Rain erosion Background



2 CFD analysis

Droplet impact pressure

Springer Model (Lifetime Prediction)

Impact Pressure Model	Coating Stress Model	Fatigue Strength Model
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$$\sigma = \frac{\rho_1 c_1 v}{1 + \frac{\rho_1 c_1}{\rho_s c_s}}$$

Modified water hammer equation

Water hammer equation
(developed for the uniform pipe flows)

$$\sigma = \rho c v$$



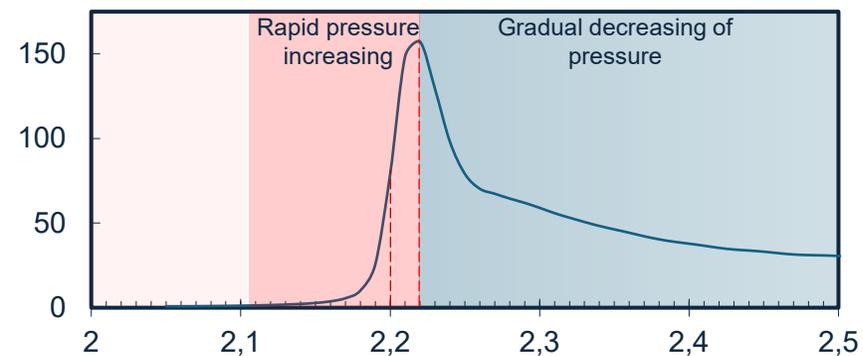
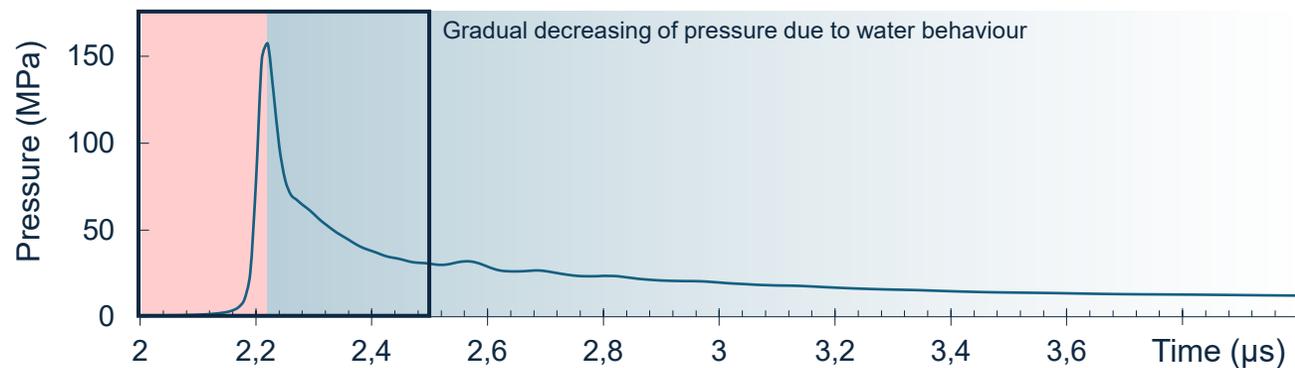
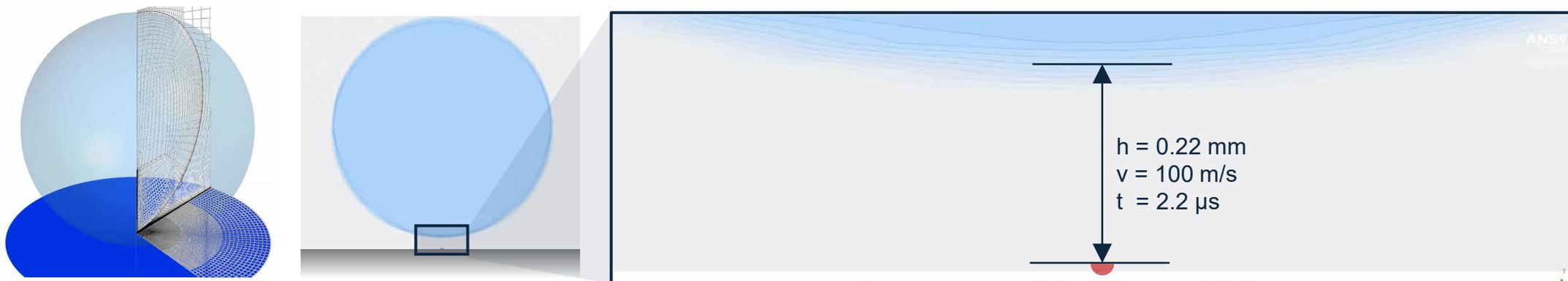
Droplet impact is
different phenomenon

Both water & air phases are active
Dependency of droplet size
Variation of pressure with time

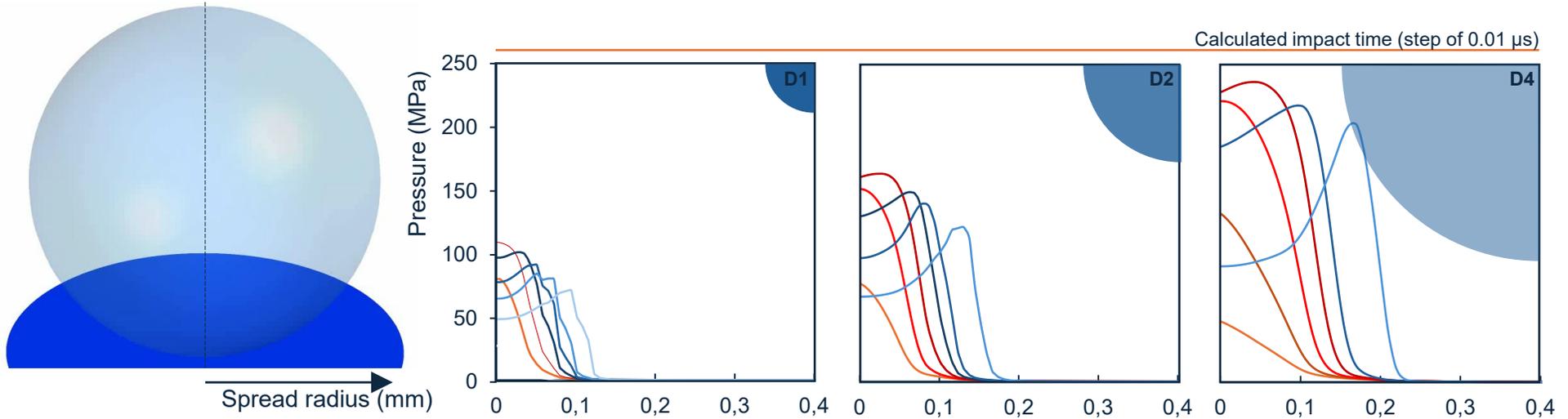


Enhance the reliability of
Springer Model:
Using CFD impact pressure

2 CFD analysis Droplet impact pressure

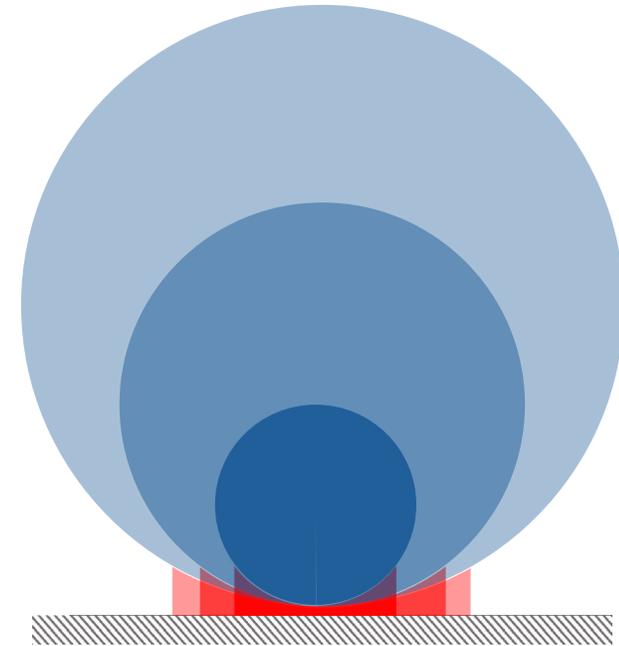
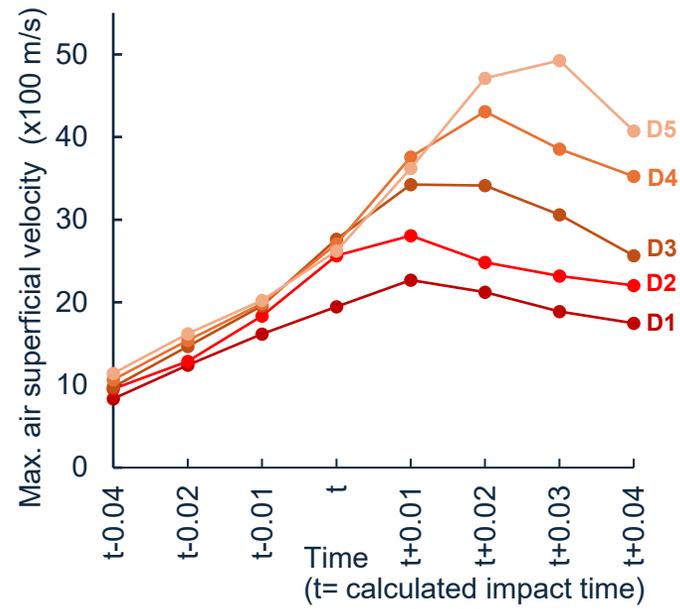
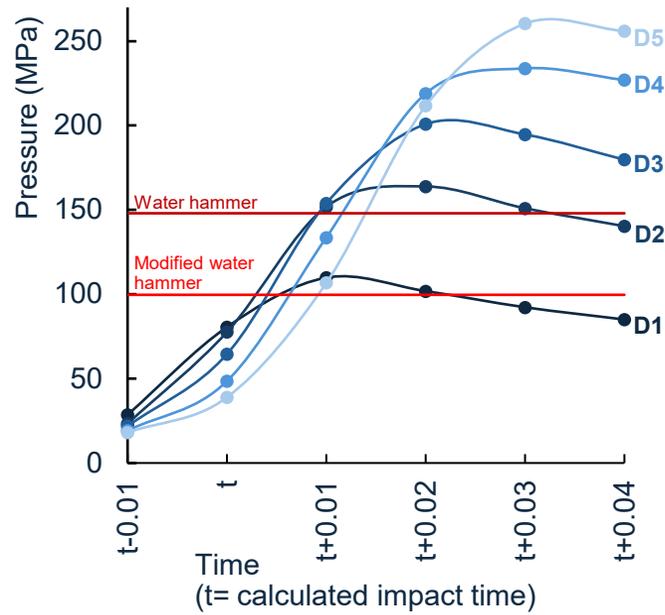


3 Pressure variation Reason



3 Pressure variation

Reason



SUMMARY

Rain induced erosion on WT blades
Impact on performance especially OWTs

CFD study on Impact Pressure
To enhance the springer model

Impact of different droplet sizes
Pressure increment for larger droplets
Air displacement behaviour during the impact

Acknowledgement:

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Thank you!



Discussion ...