University of BRISTOL

Optimisation of Wind Turbine Blade Structural Topology

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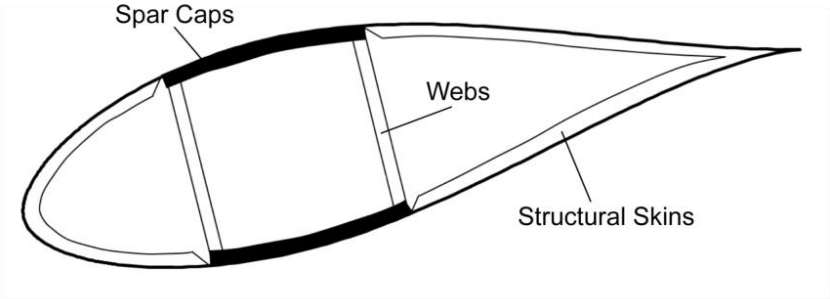
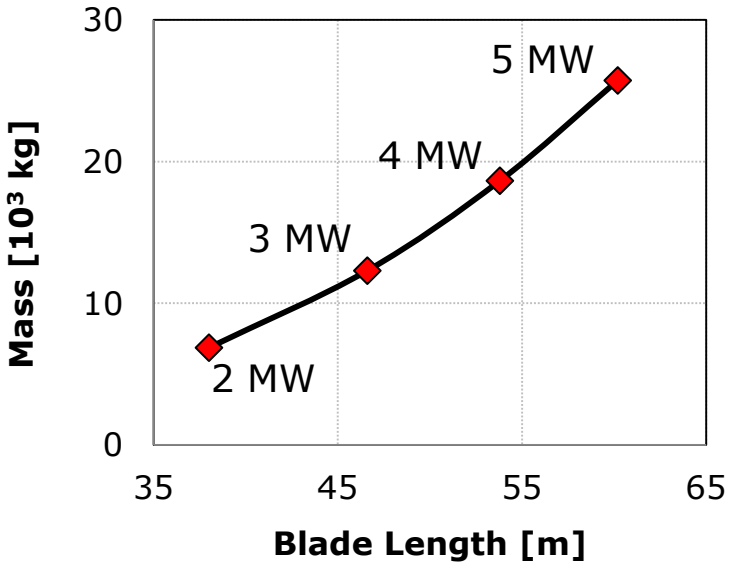
Introduction



- Wind turbine blades
  - Current blade designs
  - Square-cubic law between power and mass
  - Lightweight blades



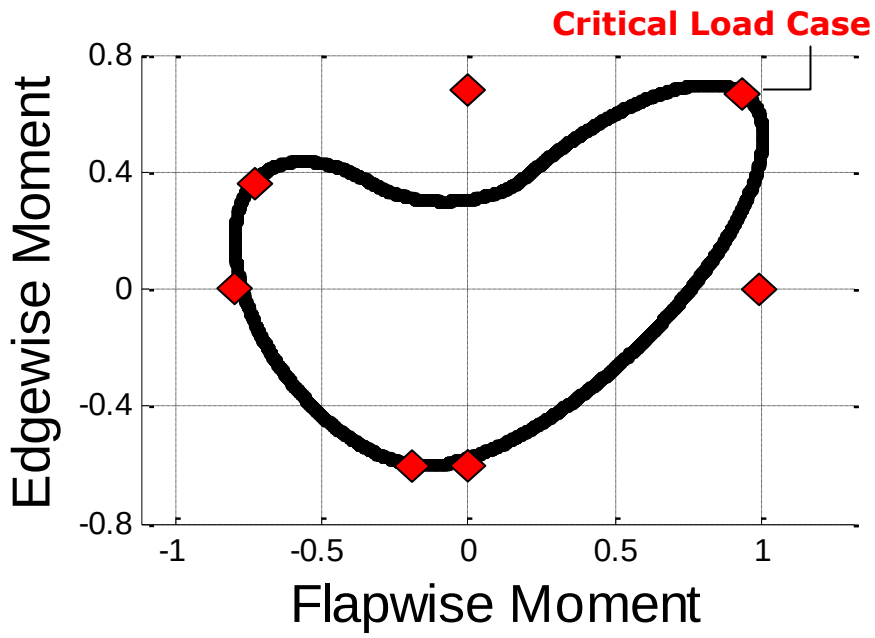
Aims and Objectives

The overall aim is to reduce the cost of wind energy by increasing blade structural efficiency (reduce mass)

- Investigate alternative structural layouts using topology optimisation
- Evaluate and understand these layouts in terms of structural efficiency using shape factors

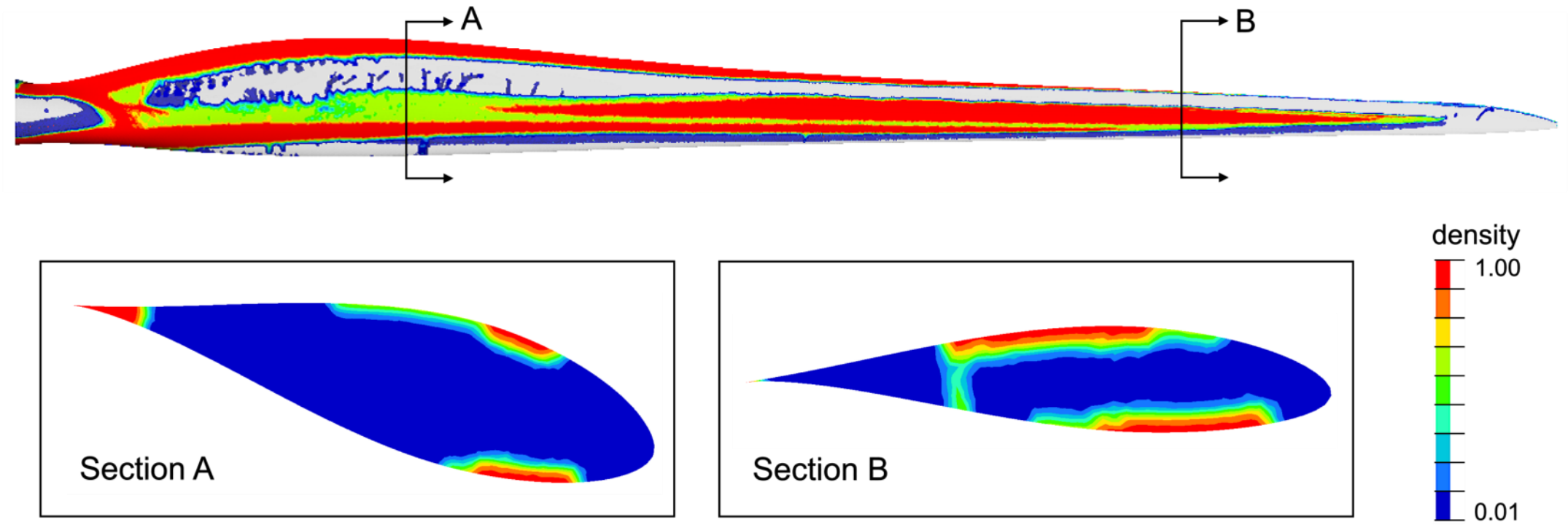
Topology Optimisation

- Topology optimisation
  - Gives optimal material distribution
  - Provides non-intuitive solutions
  - Topology is altered by changing a fictional element density
  - This modifies element stiffness
- Optimisation problem
  - Seven key load cases
  - Large model size



Objective:	min(max) compliance
Subject to:	$v_f < 0.125$
	$\delta tip < 9m$
	$\theta < 2°$

Topology Optimisation

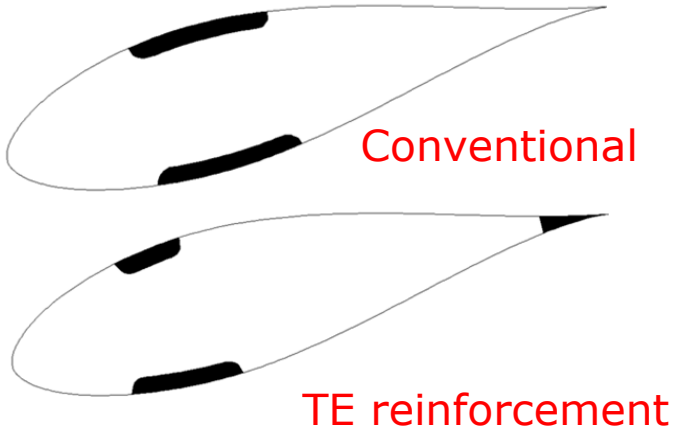


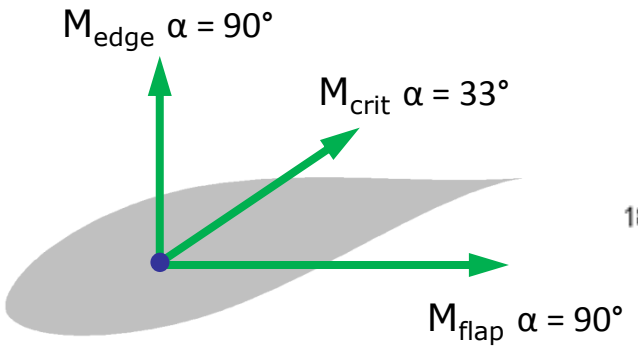
Trailing edge (TE) Reinforcement

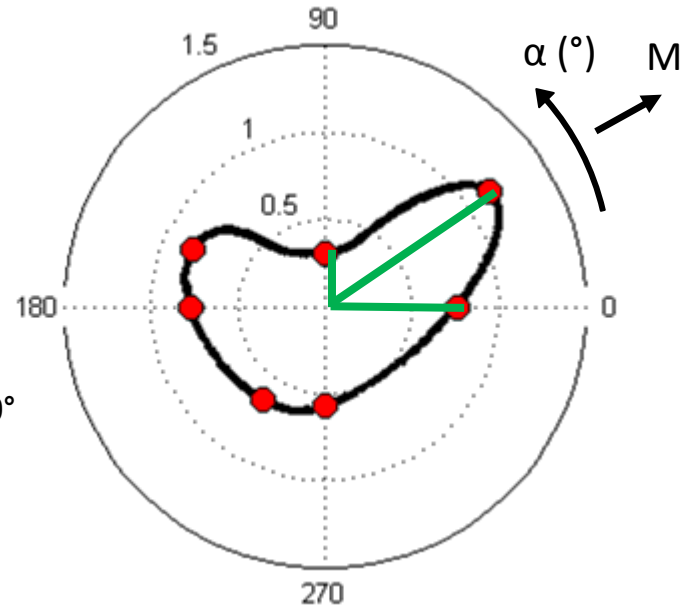
Offset Spar Caps

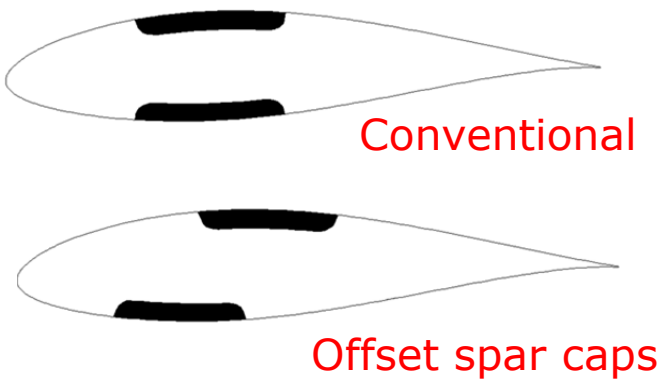
Structural Efficiency

- Shape Factors
  - Determines the efficiency of material usage in a structure
  - Account for complex bending
  - Deflection and stress
  - Depend only on the direction of loading

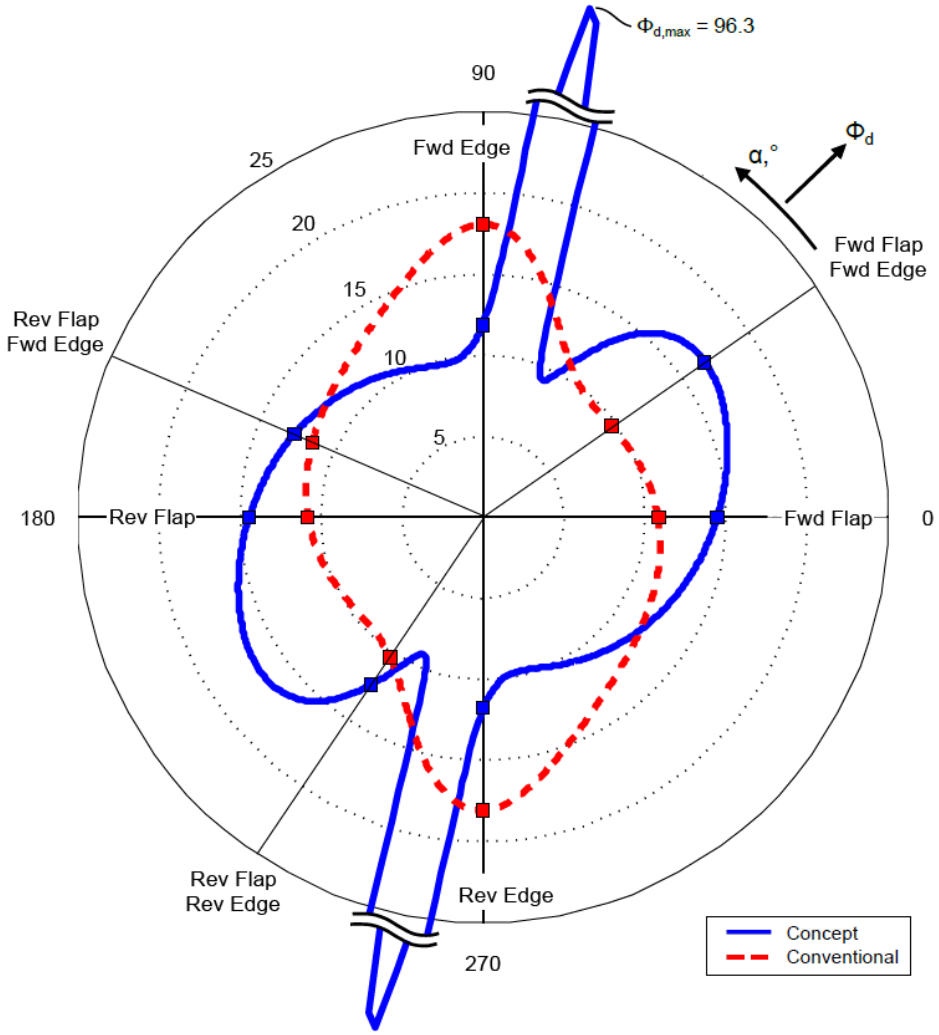




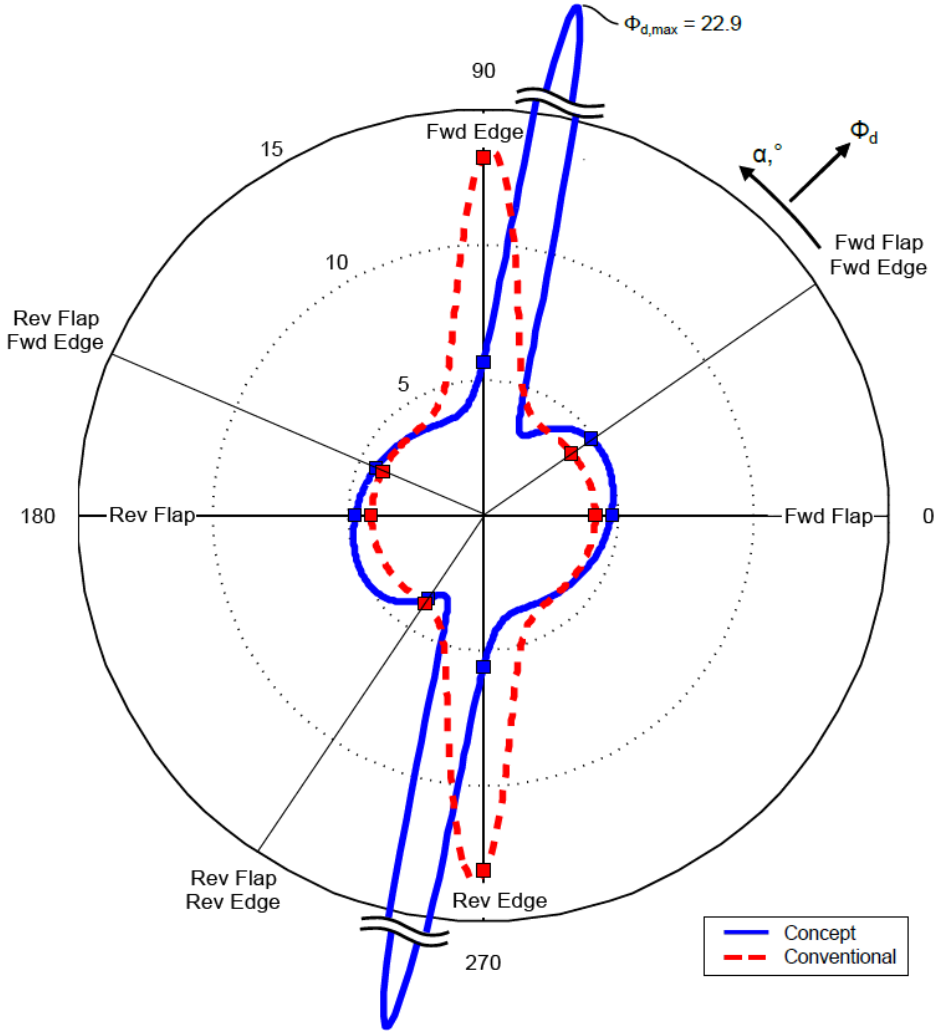




Deflection Shape Factor

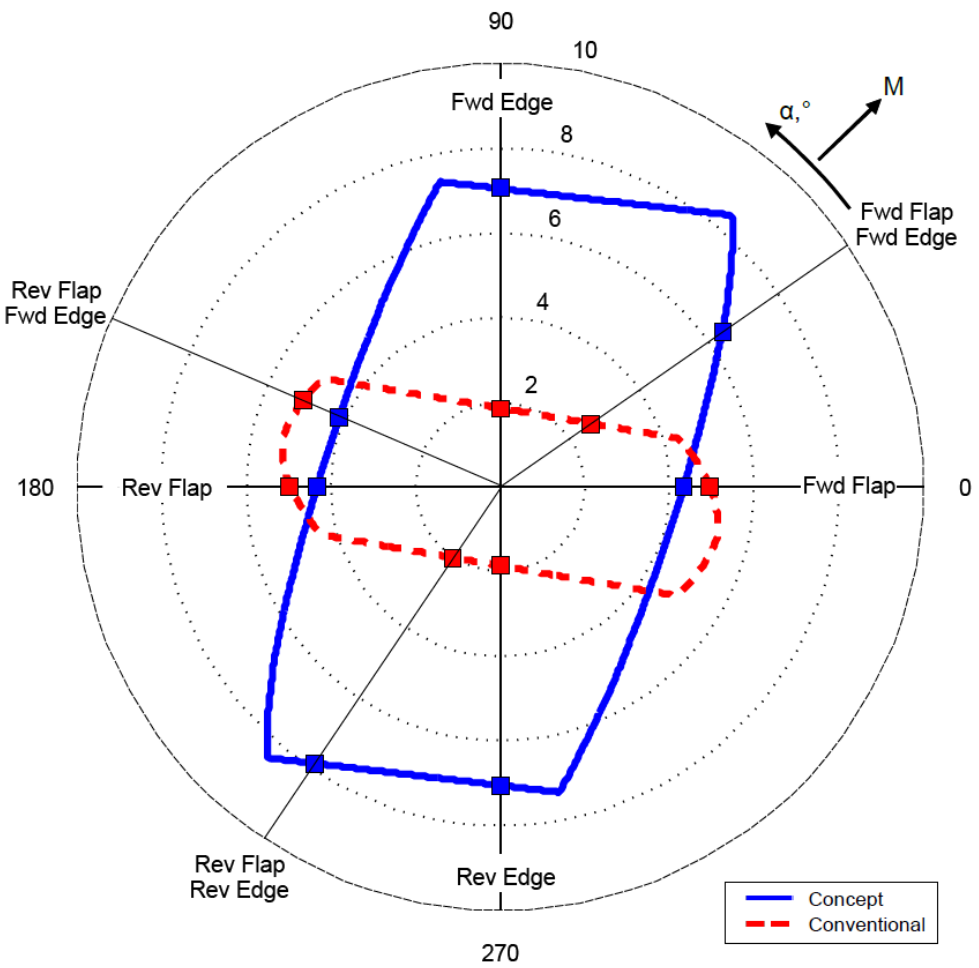


Radius = 25%

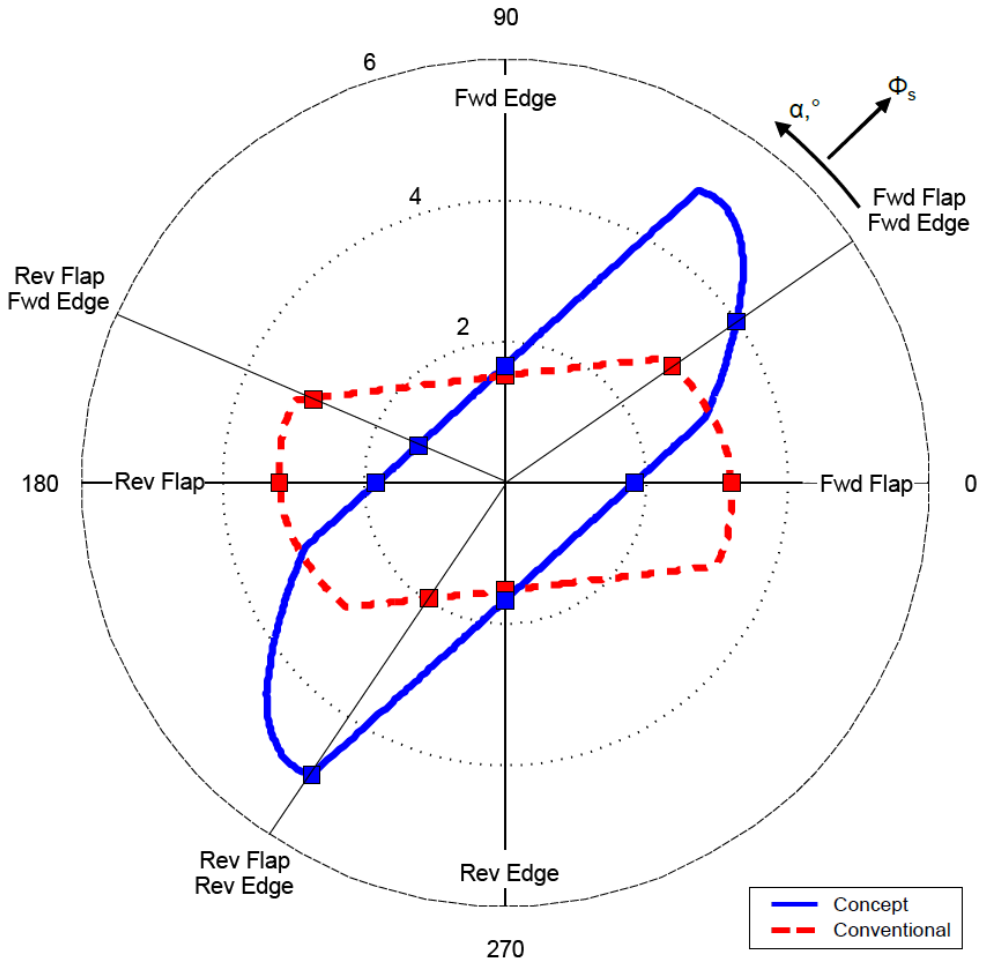


Radius = 75%

Stress Shape Factor



Radius = 25%



Radius = 75%

Conclusion

- An alternative structural layout was found using topology optimization
- The new layout is more efficient in terms of minimizing deflection and stress

From this, two observations are made:

1. Alternative layouts could be used to reduce blade weight
2. It is crucial to consider asymmetric bending in wind turbine blades

Questions