Finite element modelling of slewing bearings

Mesh design, internal contacts, preload

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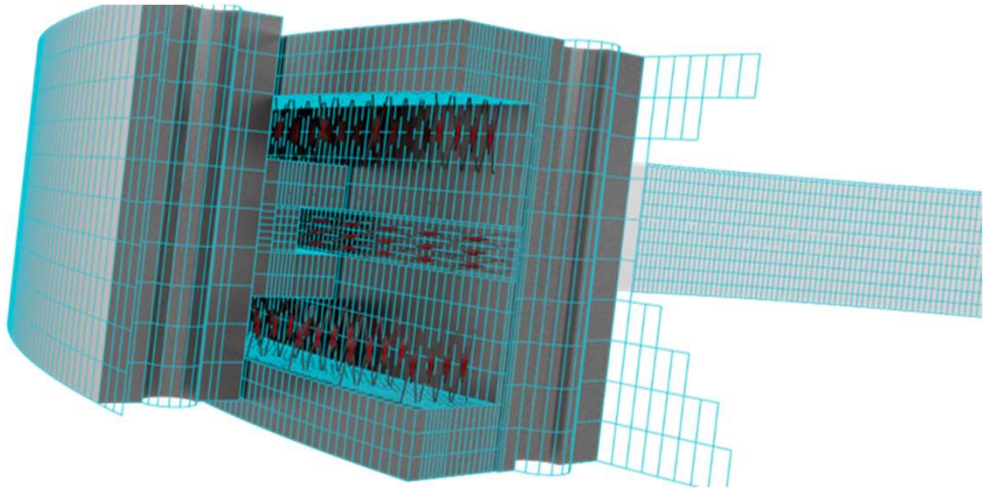
Outline

- Introduction
- Mesh design
- Modelling of rolling elements
- Contact angle analysis
- Implementation of preload
- Internal load distribution



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Introduction

Objective target

- Investigation of highly loaded raceway sections in a blade bearing

Approach

- Simulation of realistic load states of blade bearings considering entire rotor star

Tool

- Parametric global FE-models of blade bearing with acceptable computational effort

Rotor star model

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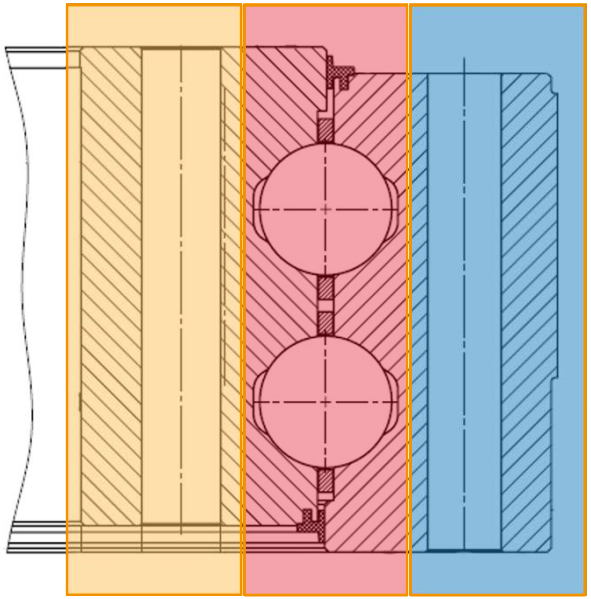
Doublerow four-point contact ball bearing

- Implementation of bolt holes in bearing rings

- Modelling the contact between ball and raceway requires specific node pattern

Challenge

- Unequal division of bolt holes in rings and balls on raceway



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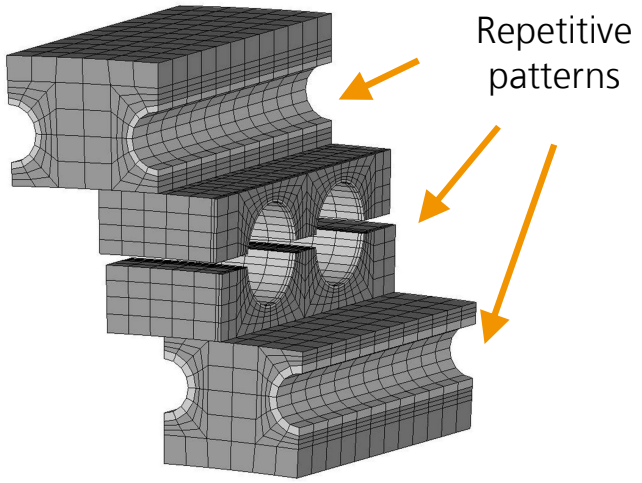
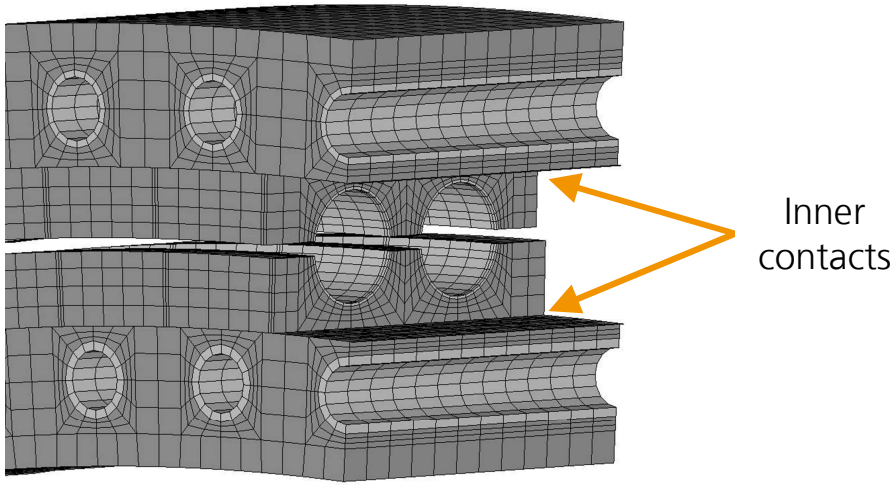
Doublerow four-point contact ball bearing





Mesh design of bearing rings

Method

- Script based generation of node and element patterns
- Multiply and connect repetitive patterns

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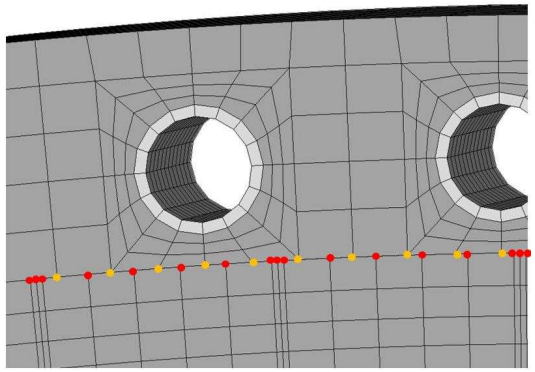
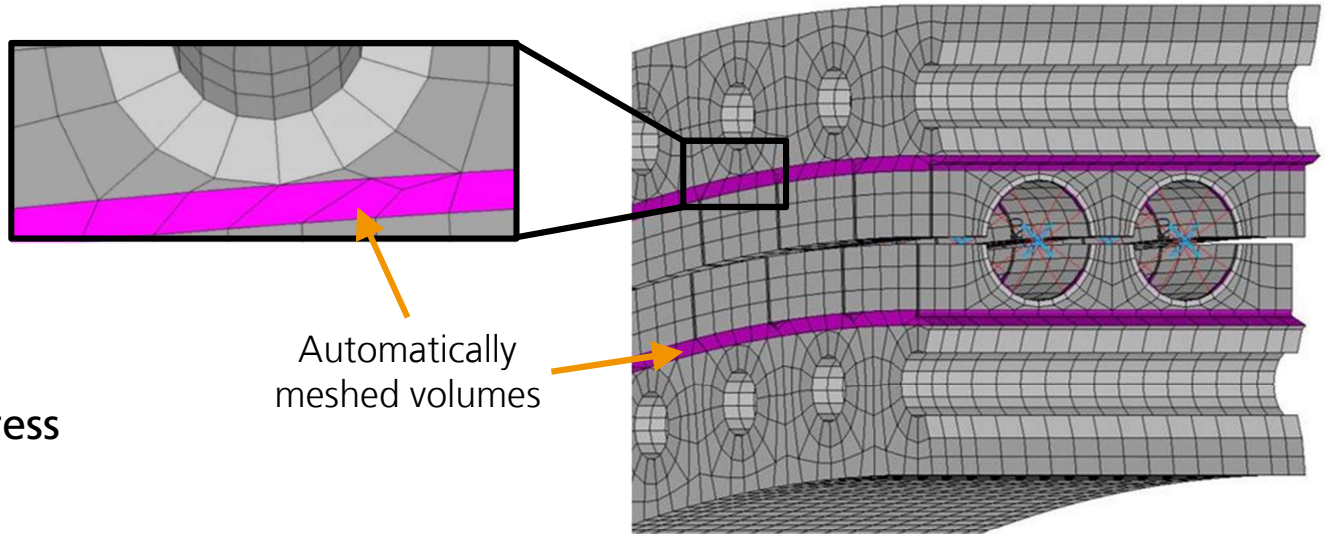
Doublerow four-point contact ball bearing





Enhanced mesh design of bearing rings

- Inner contacts can cause local stress inhomogenities
- Enhanced mesh design without contact definitions

➡ **Influence of inner contacts in bearing rings on ball forces < 2 %**

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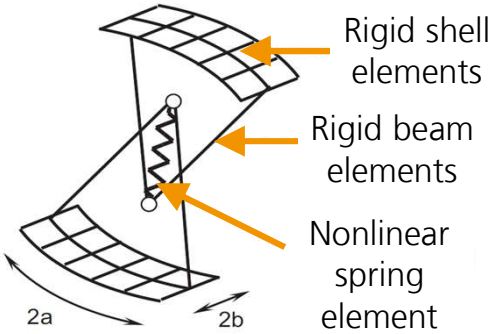
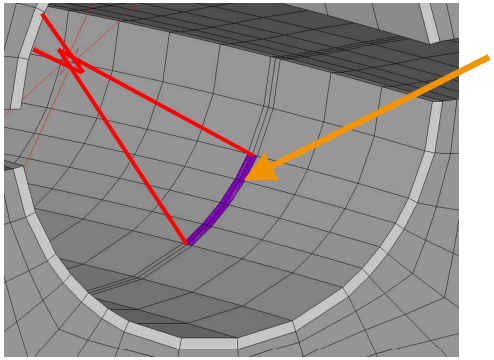
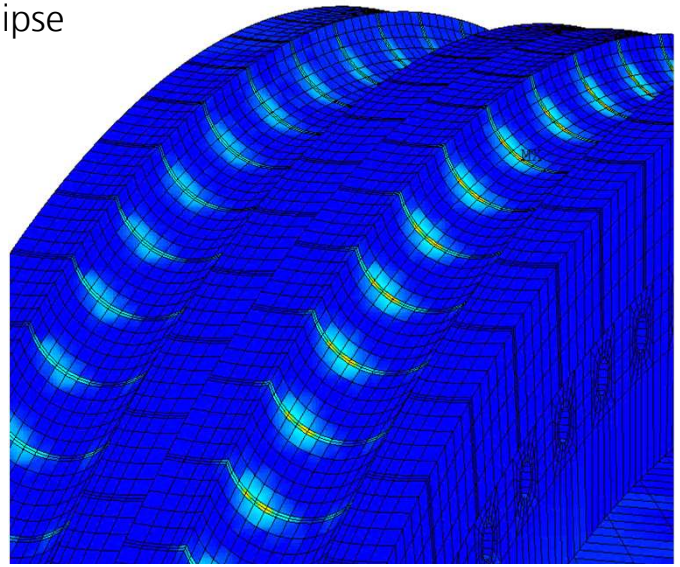
Modelling of rolling elements







Stress concentrations on bearing's inner ring

- Nonlinear spring elements represent the balls
- Shell elements represent the contact ellipse

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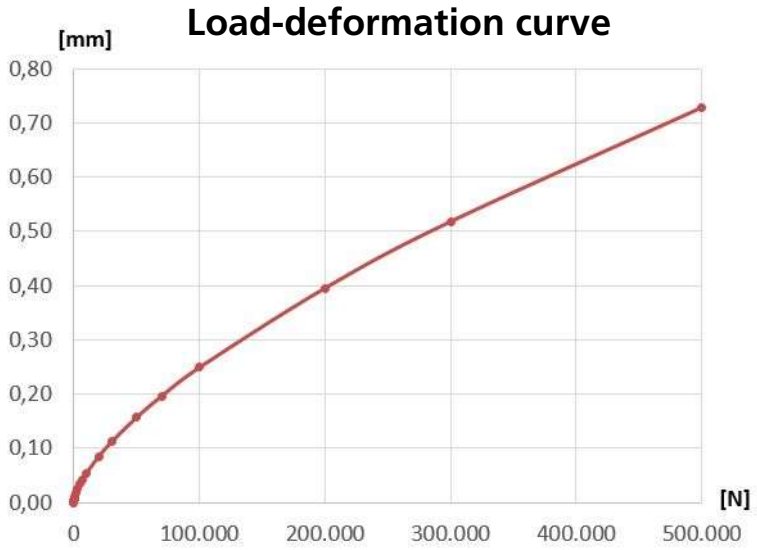
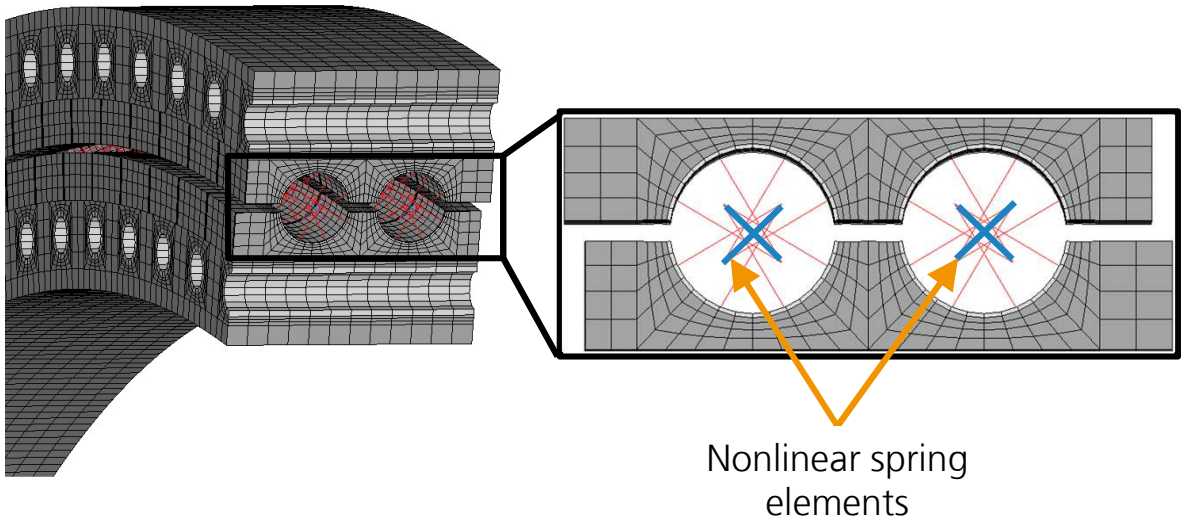
Modelling of rolling elements





- Osculation considered in load-deformation curve
- Load-deformation curve calculated according to Hertzian theory

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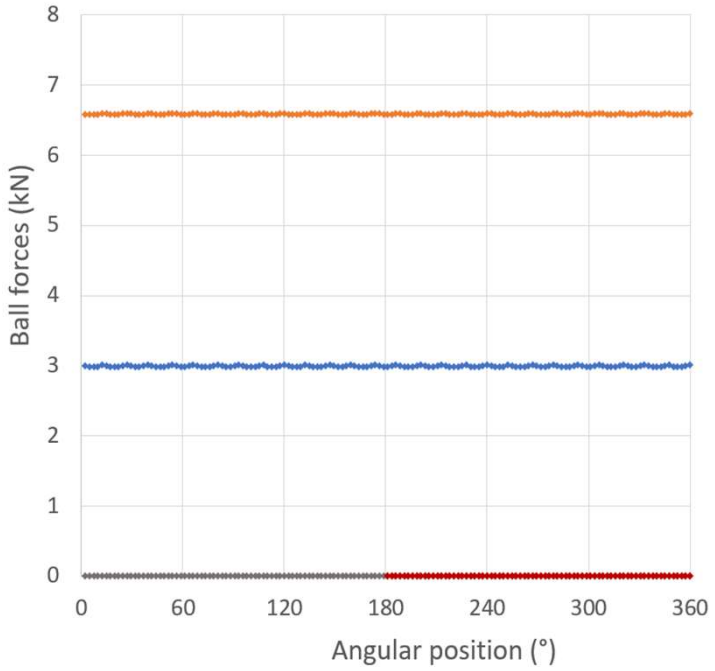
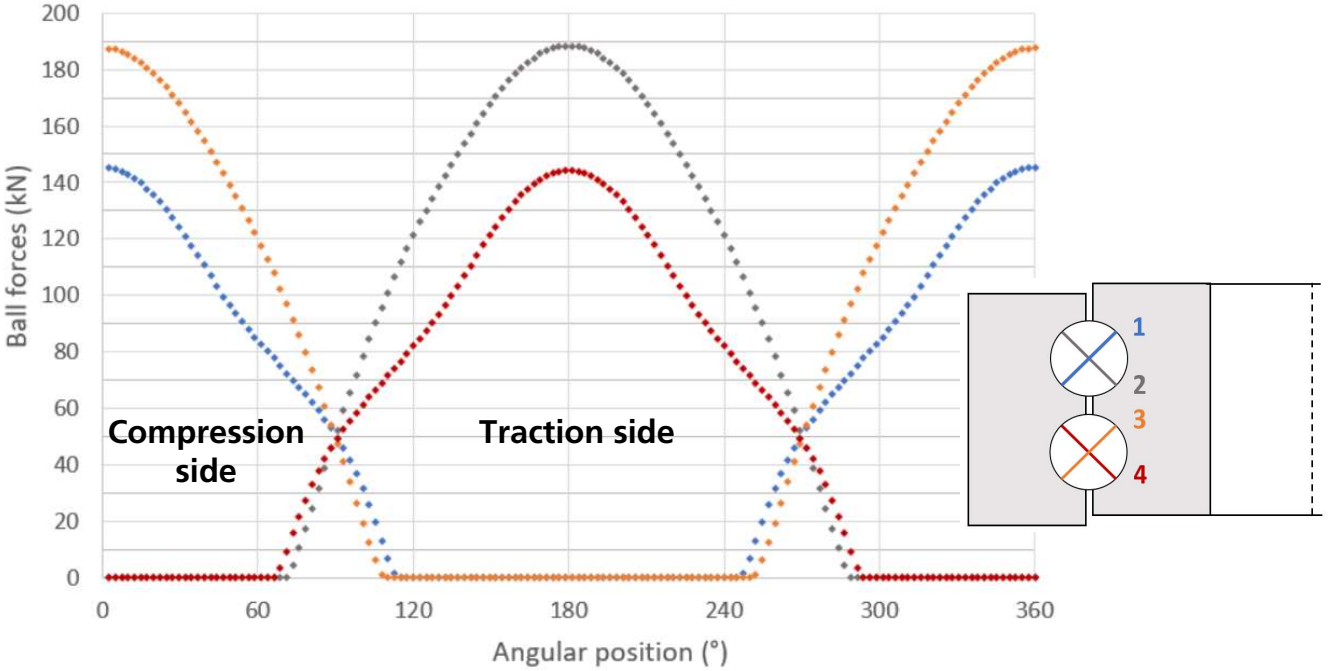
Load distribution on raceways

1 MN axial force



50 MNm bending moment



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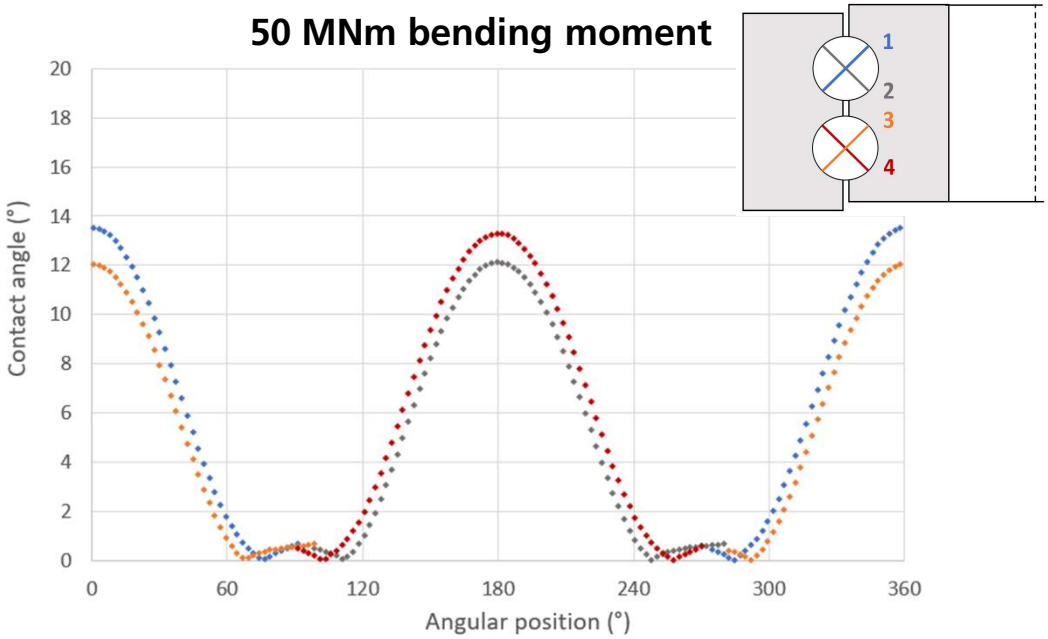
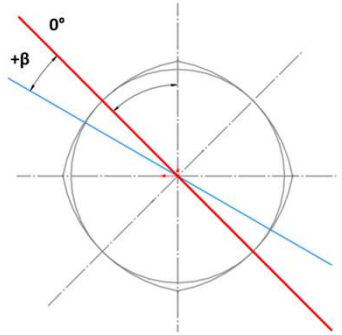
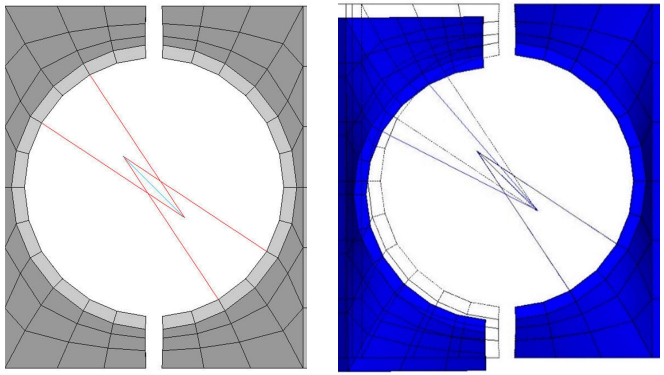
Contact angle analysis







undeformed deformed

- Tilting of nonlinear spring elements

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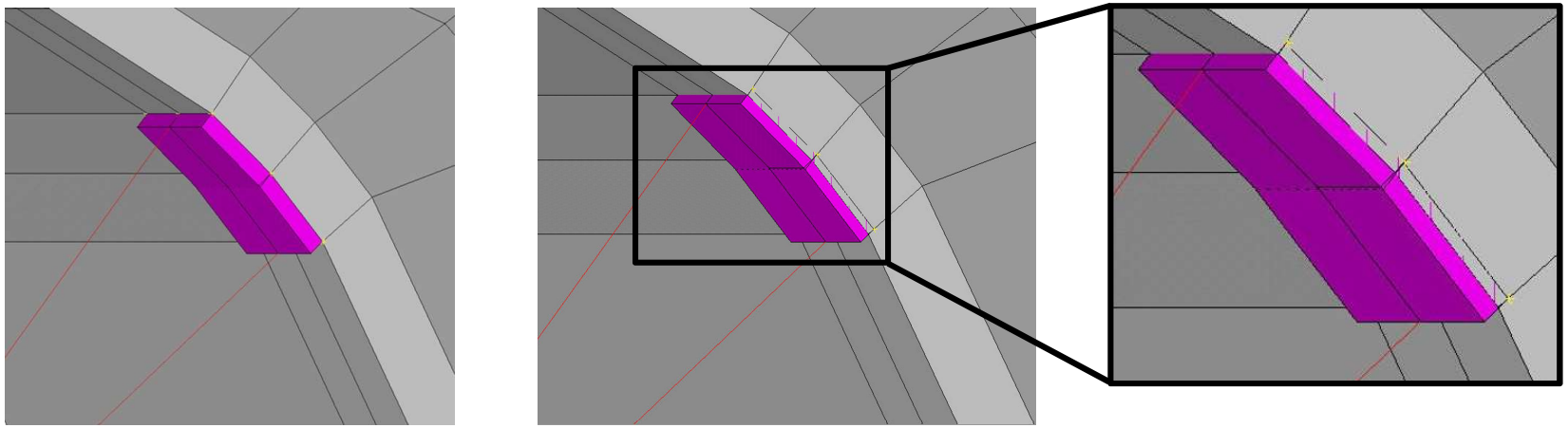
Preload analysis

- Bearing preload: Implementation of ball oversize



Without preload

With preload (inital state)

- Initial state: Shell elements of ball penetrate raceway curvature
- Preload state: Shell elements of ball touch raceway curvature

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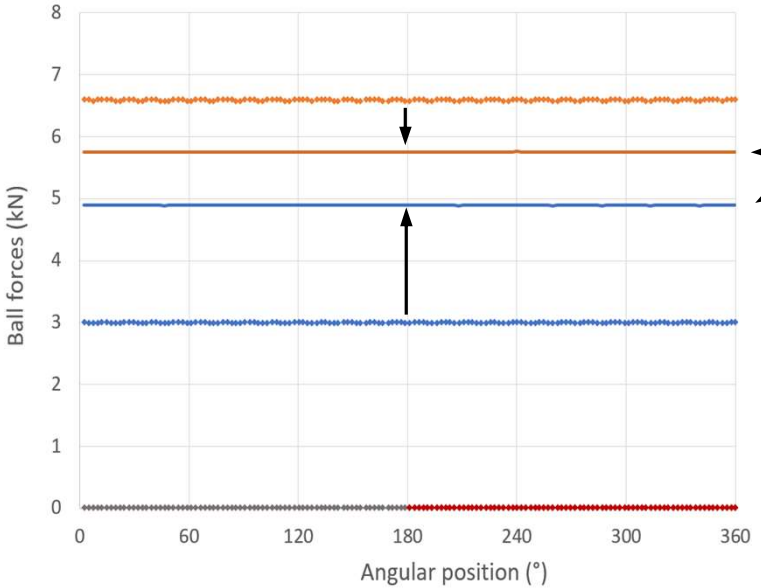
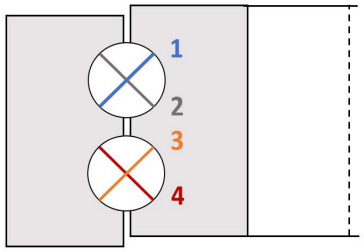
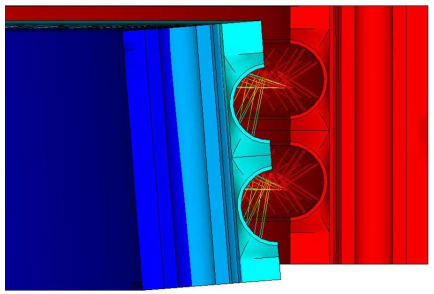
Preload analysis

1 MN axial force

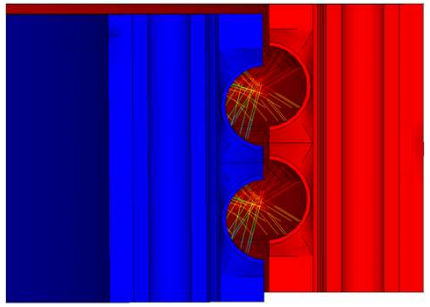


With Preload





Without preload



With preload

Preload leads to a more even load distribution between both bearing rows

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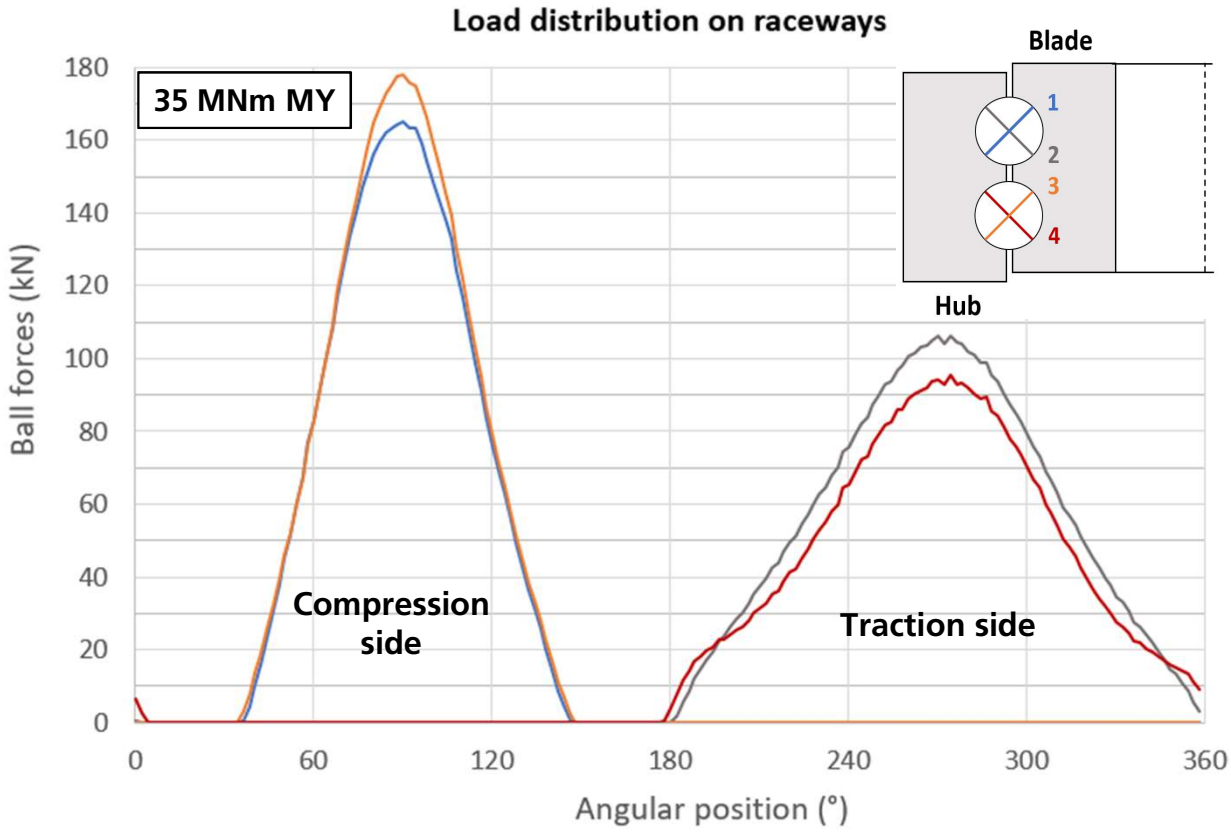
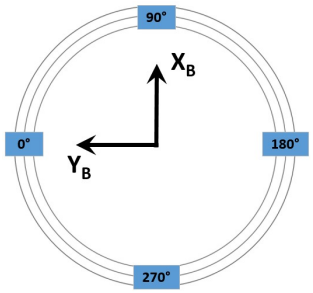
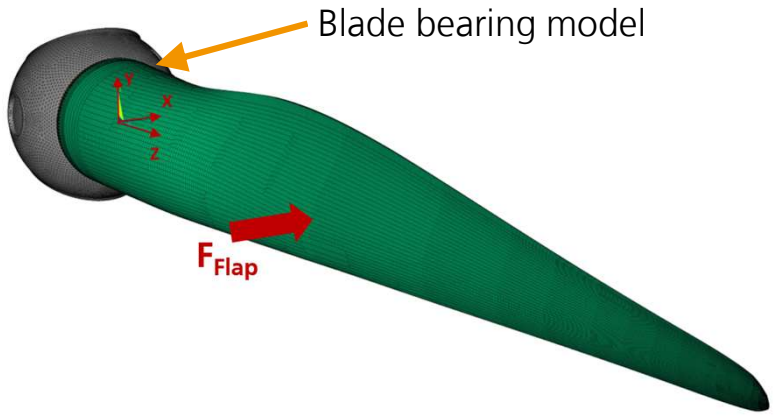
Load distribution with blade and hub







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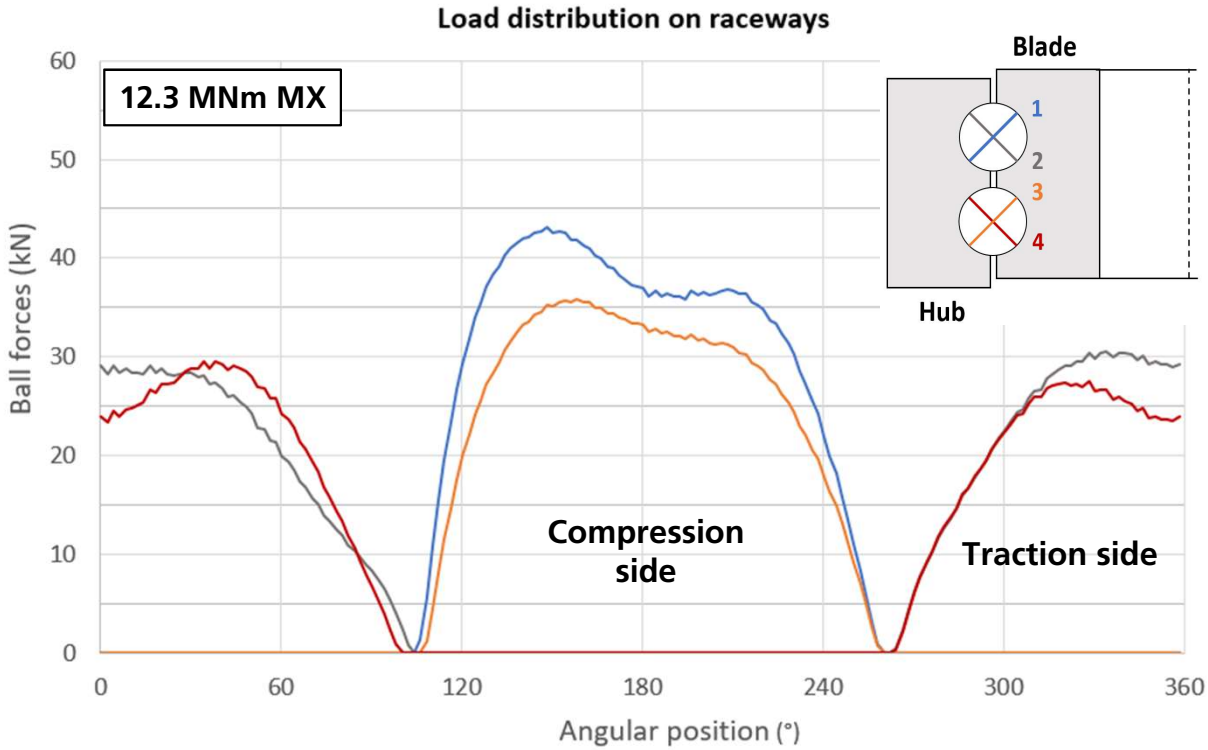
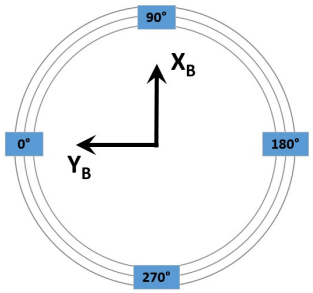
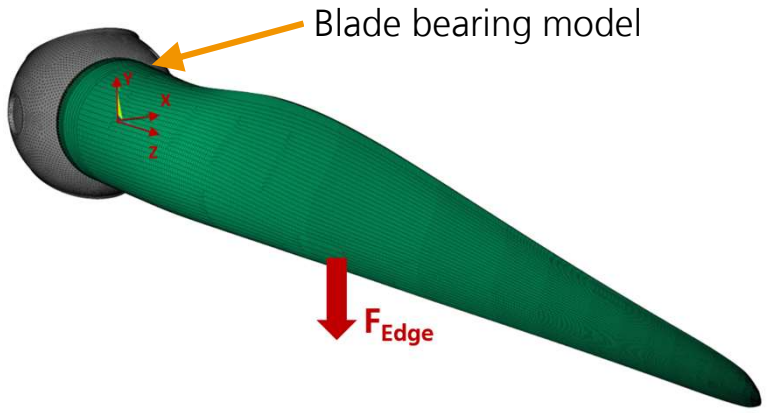
Load distribution with blade and hub







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Conclusions

- Global bearing FE-model with nonlinear spring elements allows the analysis of realistic load states and most loaded raceway sections

- Internal load distribution of a blade bearing is strongly affected by the stiffness behavior of rotor hub and rotor blade

Thanks a lot for your attention!

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