Analysis of Static Stress in a Bicycle Chain Plate

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Introduction: The chain drive is an essential component for reliable bike operation [1]. With increasing number of sprockets in a cassette the chain dimensions have to be adjusted. In this work the impact of the geometrical scaling on the mechanical stress is investigated.

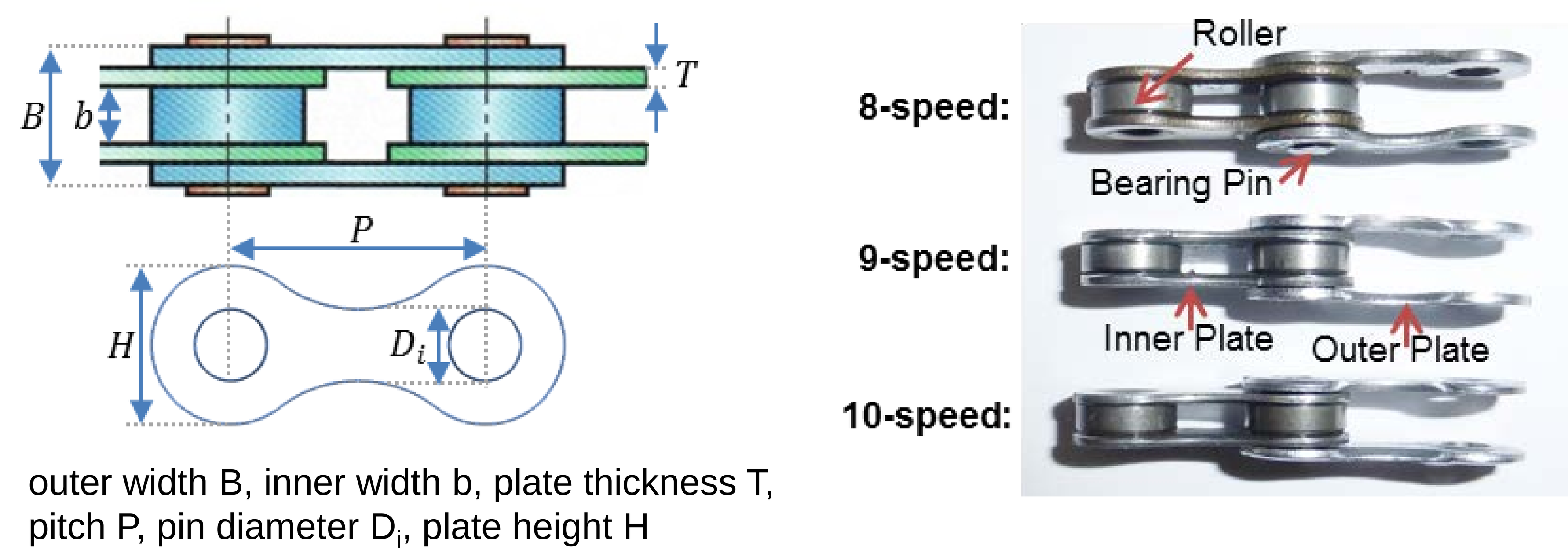

Figure 1. Chain geometry [2]

Computational Methods: The model is setup based on the *Solid Mechanics* application mode. For numeric efficiency a 2D quarter geometry of the plate is used with the plane stress approximation.

The bearing pin is used to apply the load by contact modelling.

In order to model plasticity the according sub-node below *Linear Elastic Material* is enabled.

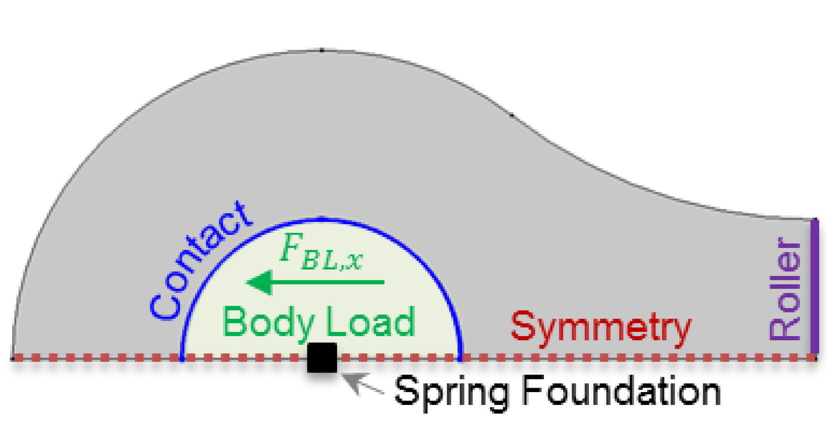

Figure 2. Boundary conditions

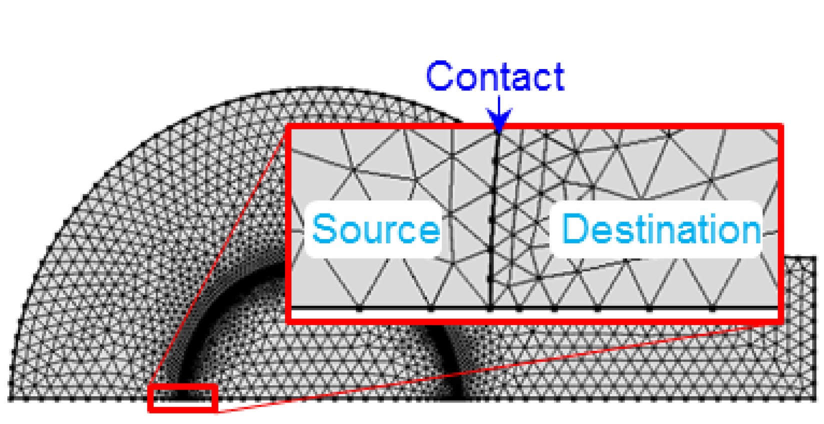

Figure 3. Mesh

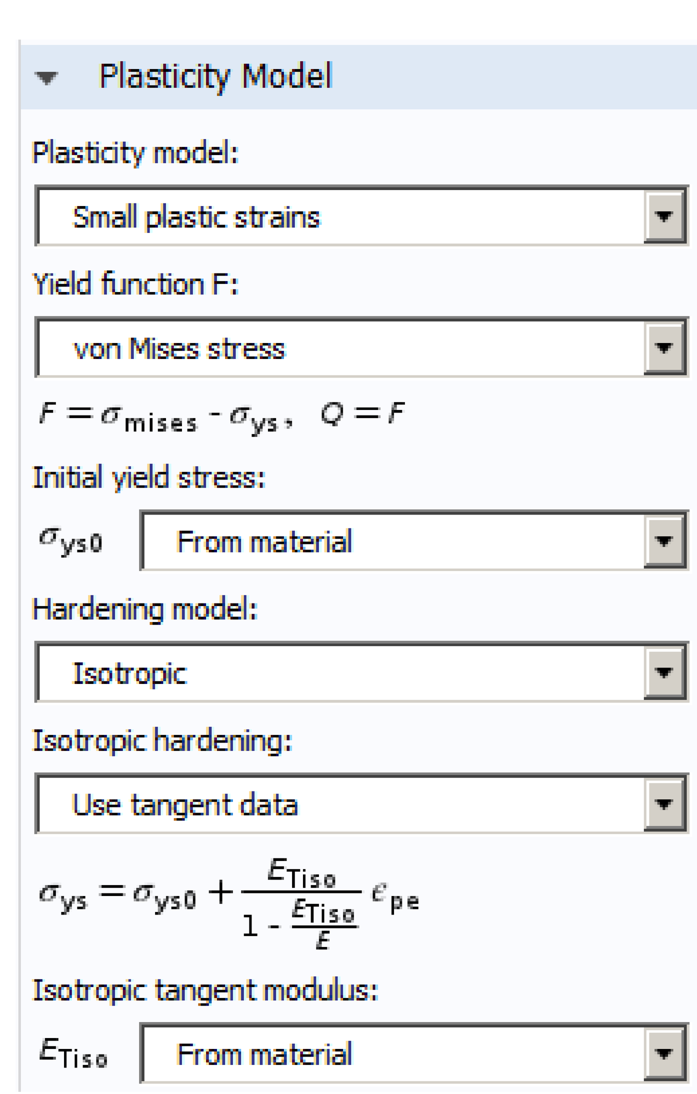

Figure 4. Plasticity Model

Results: The plate material data is summarized in Table 1. The effective plastic strain is simulated for application of two load cycles.

Table 1. 36NiCrMo16 data [3] of chain plate.

Property	Symbol	Value
Young's modulus	E	$208\ GPa$
Shear modulus	G	$80\ GPa$
Initial yield stress EN 10083 3:2006	σ_{ys0}	$1050\ MPa$
Tangent modulus	$E_{Tiso} = 0.01\ E$	$2080\ MPa$
Density	ϱ	$7840\ kg/m^3$

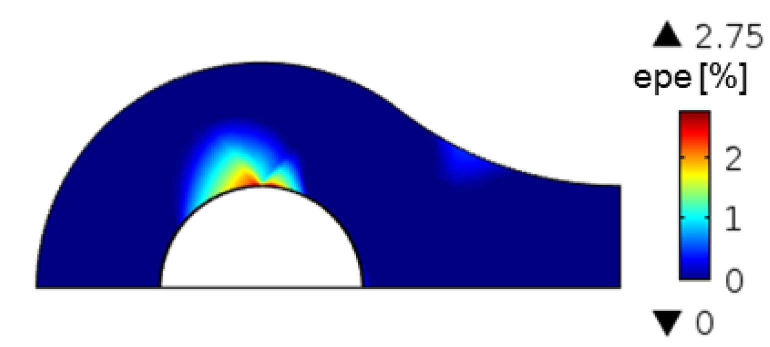

Figure 5. Plastic strain at the end of two load cycles for 9-speed chain.

Force-displacement characteristics are investigated for two load cycles. With material data of Table 1 approximately 15% for 8-speed, 50% for 9-speed and 500% for 10 speed chain of maximum wear results. Wear is reduced by a material variant [3] with increased σ_{ys0}.

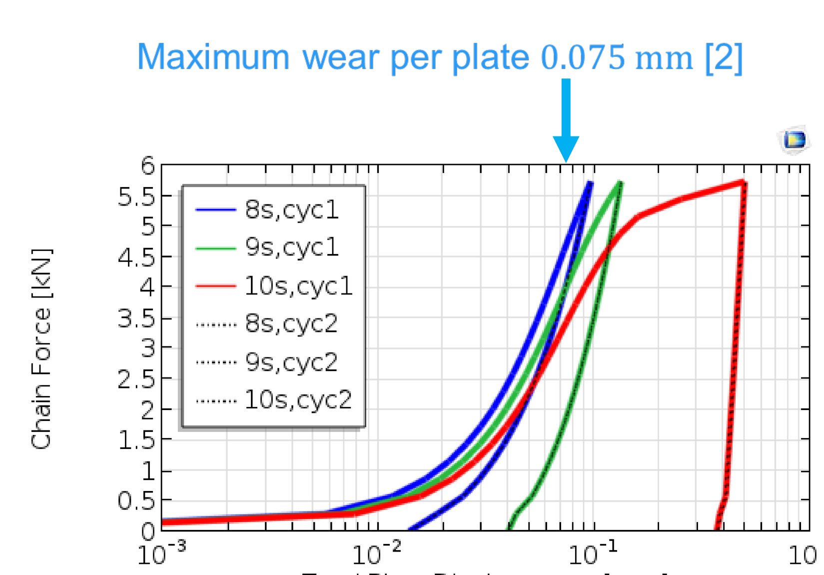

Figure 6. Displacement for 8-, 9- and 10-speed geometry (material data: cf. Tab. 1).

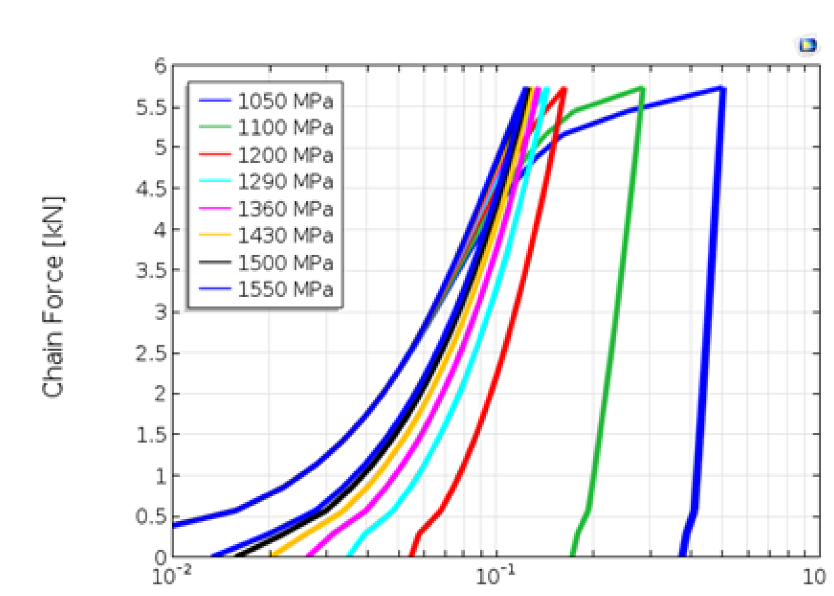

Figure 7. Displacement for 10-speed geometry for varied σ_{ys0} from [3].

Conclusions: The results suggest that common high tension steel can still be used for modern chains where scaled geometries lead to increased stress levels.

References:

[1] Shoji Noguchi et al., Static Stress Analysis of Link Plate of Roller Chain using Finite Element Method and Some Design Proposals for Weight Saving, *Journal of Advanced Mechanical Design Systems and Manufacturing*, **Vol.3**, No. 2,(2009)

[2] Michael Gressmann, Fachkunde Fahrrad-technik, Europa-Lehrmittel, Haan-Gruiten (2011)

[3] Lucefin Group, 36NiCrMo16 – Technical card,Available from: <http://www.lucefin.com/wp-content/files_mf/1536nicrmo1662.pdf> [29 July 2015]