Modeling Wear of Journal Bearings

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Introduction: Hydrodynamic Journal bearings (JB) (fig. 1) as a representative of large-area tribological contacts in internal combustion engines face increased demands in regard to life expectancy and reliability. Actual developments (e.g. start-stop technology and downsizing) push JB to operation points (mixed friction) with increased wear resulting in the necessity of numerical wear evaluation.

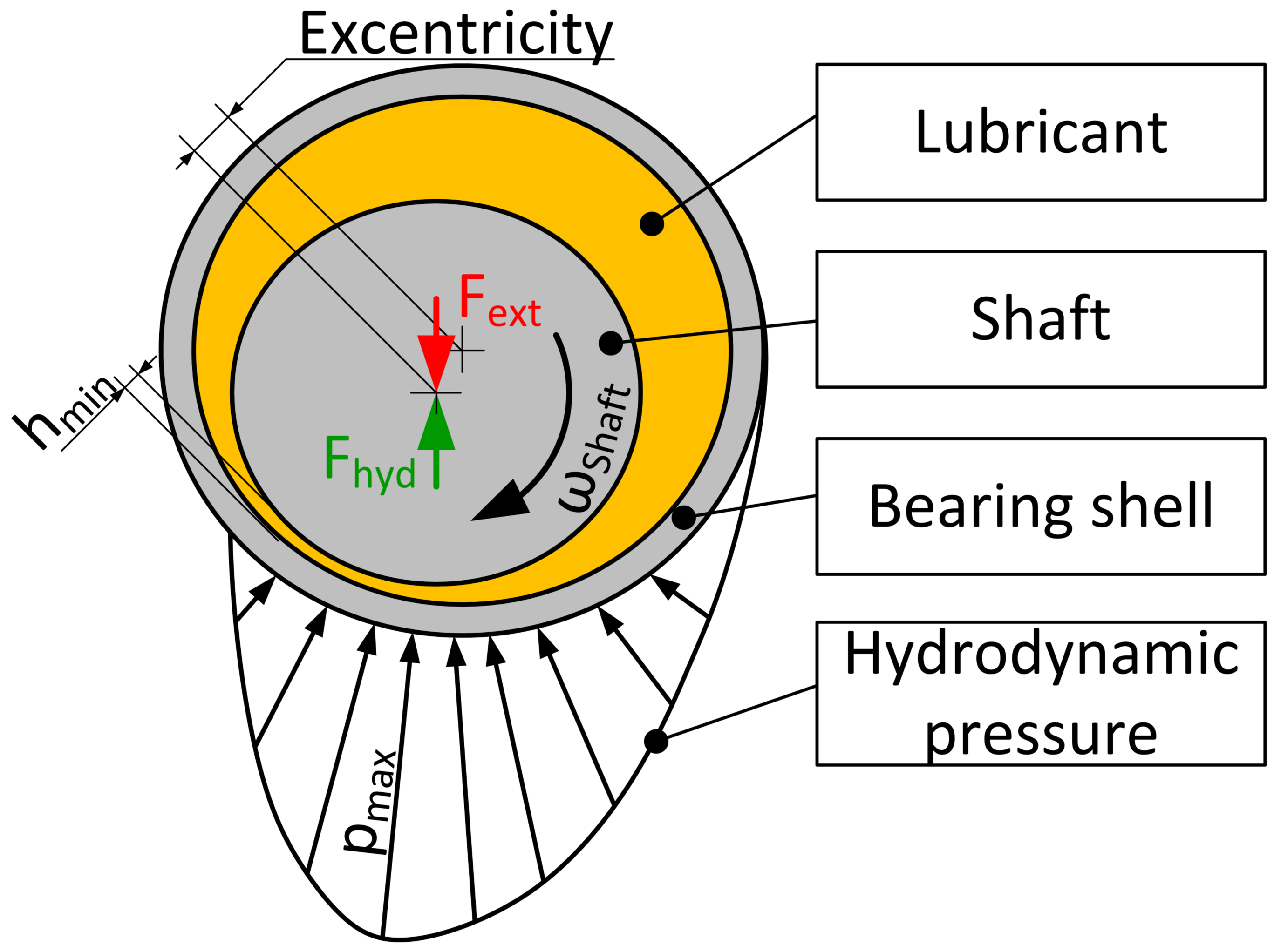

Figure 1. Principle sketch of a hydrodynamic journal bearing

Computational Methods: Mixed friction is characterized by the coexistence of hydrodynamic pressure, solved by Reynolds' equation (1), and solid contact pressure, taken into account by a load-displacement function according to [1]. The wear equation (2) based on Archard's wear law is incorporated as an ordinary differential equation [2]. The surrounding structure is the core part of a close-to-component test rig demanding equation (3) to take elastic deformation into account, fig. 2.

$$\frac{\partial}{\partial t}(\rho h)+\nabla_t\cdot(\rho h v_{av})=0 \qquad (1)$$

$$\frac{\partial h_w}{\partial t}=p\cdot C\cdot v \qquad (2)$$

$$\rho\frac{\partial^2 u}{\partial t^2}=\nabla u\cdot S+F_V \qquad (3)$$

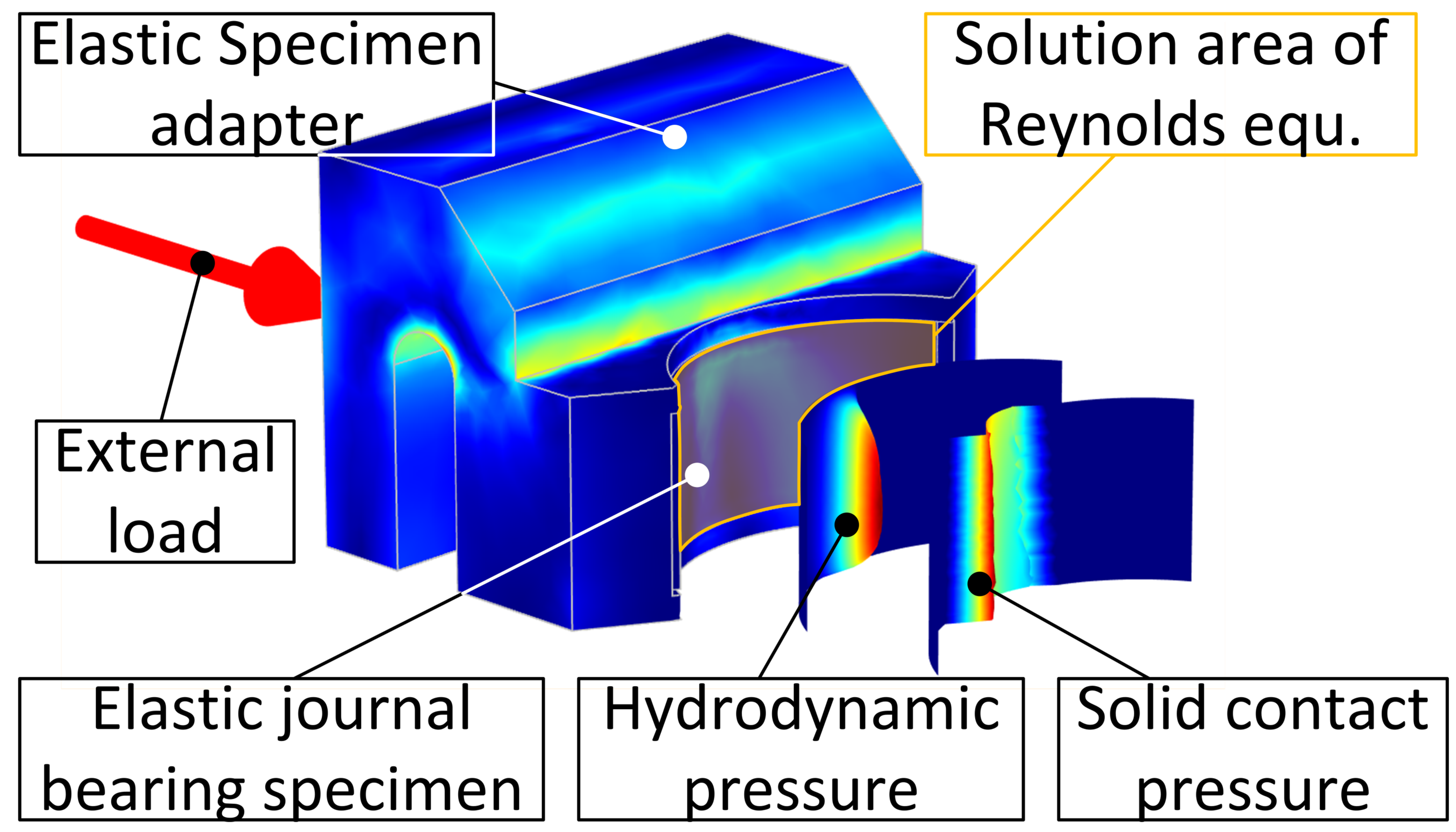

Figure 2. Model of test rig part under external load in mixed friction operation (hyd. and solid pressure)

Results: The conducted time dependent wear investigation yields a wear induced change in force equilibrium (fig. 3,a) and the according evolution of wear pattern (fig. 3,b).

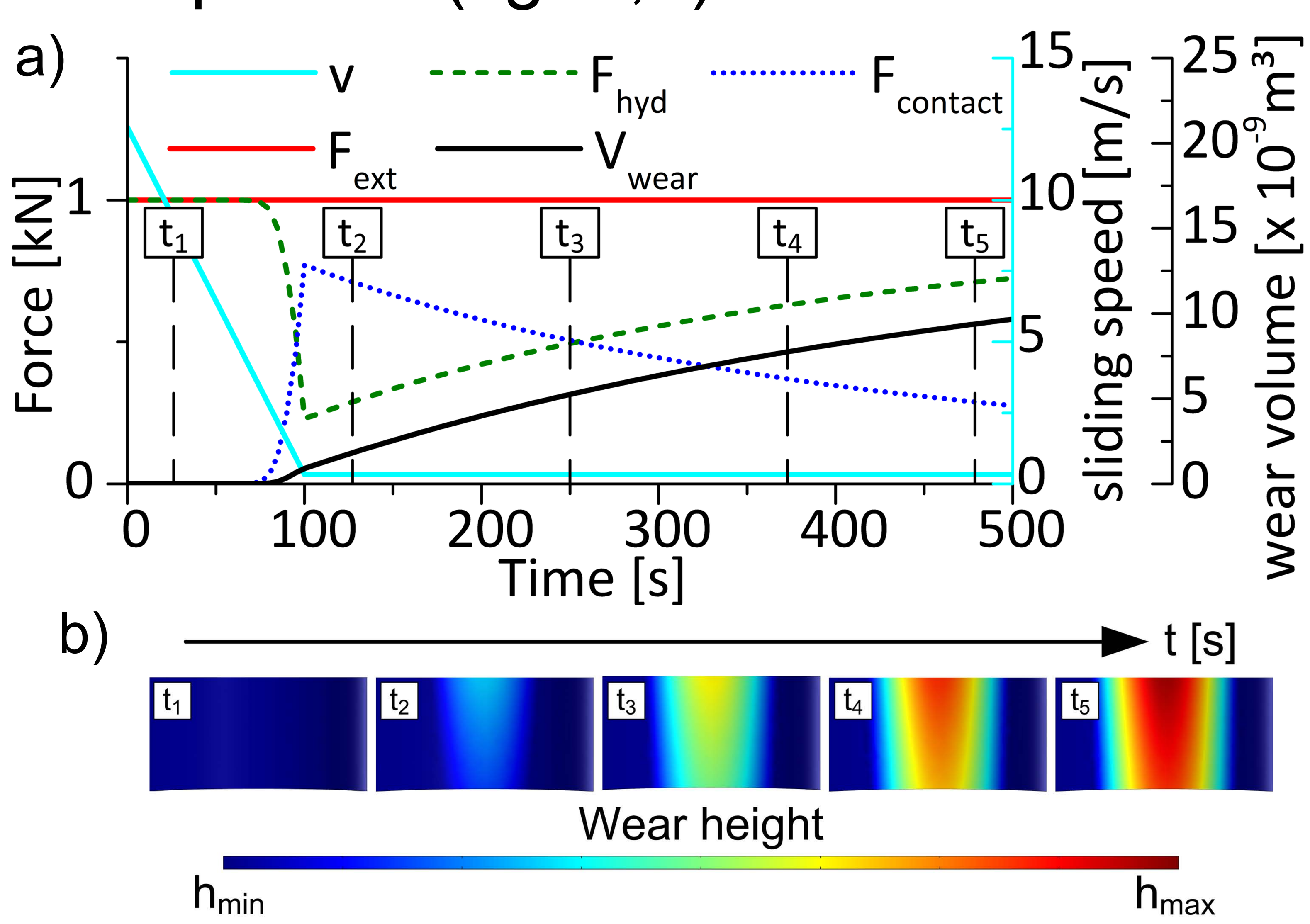

Figure 3. a) run of force equilibrium and wear, b) chronologically and locally resolved evolution of wear

Conclusions: The developed numerical methodology in COMSOL allows the calculation of progressive wear locally and chronologically resolved for arbitrary large area contacts based on empirically determined wear constants C.

References:

1. Greenwood, J.A., Wiliamson, J.B.P, Contact of Nominally Flat Surfaces, Proceedings of the royal society, 295, 300-319
2. Elabbasi, N., Simulating Wear in Disc Brakes, COMSOL Conference 2014 Boston