

NOVEL ENGINEERING APPROACH TO DETERMINE THE ELECTRICAL CAPACITANCE OF MACHINE ELEMENTS WITH LINE CONTACTS

V. Schneider ^{a*}, M. Krewer ^a, G. Poll ^a

*schneider@imkt.uni-hannover.de

^a Institute of Machine Design and Tribology,
postal adress1, country1

KEYWORDS

Modelling in tribology; EHL; Hydrodynamic lubrication, Electrical capacitance

ABSTRACT

The electrical capacitance of machine elements plays a crucial role in anticipating harmful currents in bearing and gear contacts, potentially leading to premature system failure [1]. Previous studies have established empirical models to compute bearing capacitance for point contacts, avoiding time-consuming numerical computations for an efficient engineering approach to estimate harmful currents [2].

This research extends these models to machine elements with line contacts, also offering an easy-to-use engineering approach. Extensive numerical simulations were conducted to derive an empirical formula for calculating the total capacitance from the easily calculable Hertz'ian contact capacitance, facilitating its application. The empirical formula includes the capacitance influence caused by the non-uniform deformation in- and outside the highly loaded Hertz'ian contact as well as the influence of the areas, which surround this Hertz'ian area.

For cylindrical roller bearings (CRBs), total capacitance calculation involves considering roller rib contacts in addition to roller raceway contacts. For gear contacts it is important to also perform a time-transient analysis of capacitance along the line of action, considering double and single engagements with adjacent teeth. Tooth and roller profiling, typically logarithmic, is normally used to mitigate harmful edge stresses by distributing the load more evenly along the contact length. But this also means that, depending on the load, not the entire length of the contact partners is loaded and there are unloaded areas, which needs to be considered in the total capacitance. Usually, the loaded and unloaded areas are calculated using slice models [3], [4], [5].

The derived methods were validated using experimental investigations [6]. Also, the influence of the position of the roller between the guide ribs on the total capacitance of a CRB

is discussed.

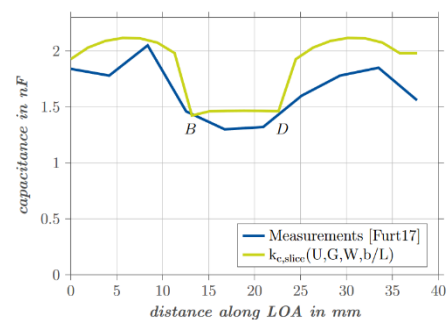


Fig.2 Comparison of calculated and measured [6] capacitances of a gear contact along the line of action

REFERENCES

- [1] V. Hausberg, „Elektrische Lagerbeanspruchung umrichter gespeister Induktionsmaschinen“, Leibniz Universität Hannover, 2001.
- [2] V. Schneider, N. Bader, H. Liu, und G. Poll, „Method for in situ film thickness measurement of ball bearings under combined loading using capacitance measurements“, *Tribology International*, Bd. 171, S. 107524, Juli 2022, doi: 10.1016/j.triboint.2022.107524.
- [3] H. Reusner, „Druckflächenbelastung und Oberflächenverschiebung im Wälzkontakt von Rotationskörpern“, Karlsruher Institut für Technologie, Karlsruhe, 1977.
- [4] R. Teutsch, „Kontaktmodelle und Strategien zur Simulation von Wälzlagern und Wälzführungen“, Technische Universität Kaiserslautern, 2004.
- [5] L. Houpert, „Novel analytical and numerical calculations in truncated contact“, *Bearing World Journal*, 2019.
- [6] A. Furtmann, „Elektrische Belastung von Maschinenelementen im Antriebsstrang“, Leibniz Universität Hannover, 2017.