# Model order reduction on stationary and dynamical isothermal Newtonian EHD contacts

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## Abstract

We are introducing a method to decrease the calculation time of EHD contacts. The method is based on model order reduction (MOR) techniques [1] and will be applied to a stationary and dynamical isothermal Newtonian EHD contact. The contact problem is arranged as one full system of equations [2] – including Reynolds equation with cavitation condition, elasticity equation and force balance – and solved directly. The full system is solved iteratively by a Newton method with an active set procedure accounting for the unilateral constraints related to the chosen cavitation model. The reduction procedure is executed not only on the linear part representing the elasticity equation of the EHD contact problem [3] but also on the strongly nonlinear and parametric part given by the Reynolds equation. To cope with the cavitation condition within the reduced system, the cavitational area is separated from the computational area and the boundary between those two areas is adapted iteratively. Furthermore the costs of constructing the reduced system are cut by approximating the reduced system function and its Jacobian using only a few distinguished nodes [4].

We will investigate accuracy and efficiency of the partially reduced system (only linear part), the fully reduced system and the fully reduced system with system approximation (SA) compared to the full system.

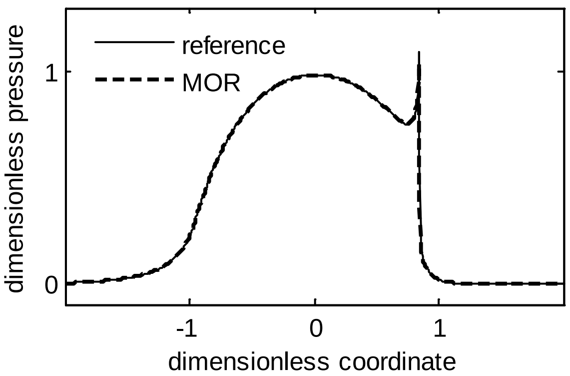


Fig.1 MOR approximation of pressure for a line contact problem

Table 1 Comparison of central film thickness for a point contact problem (M=200, L=10) with a density model based on Dowson and Higginson and the Roelands viscosity model

| **Model** | $H_c$ |
|---|---|
| Venner and Lubrecht [5] | 0.08144 |
| Habchi et al. [2] | 0.08222 |
| current model (full) | 0.082305 |
| current model (reduced) | 0.082308 |
| current model (reduced + SA) | 0.082338 |

## References

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[3] Habchi, W. and Issa, J., “Fast and reduced full-system finite element solution of elastohydrodynamic lubrication problems: Line contacts,” Advances in Engineering Software 56, 2013, 51-62.

[4] Carlberg, K., Bou-Mosleh, C. and Farhat, C., “Efficient Nonlinear Model Reduction via a Least-Squares Petrov-Galerkin Projection and Compressive Tensor Approximations,” Int. J. Numer. Meth. Engng, 86, 2011, 155-181.

[5] Venner, C.H. and Lubrecht, A.A., “Multilevel Methods in Lubrication,” Amsterdam: Elsevier (Tribology Series Vol. 37); 2000.