

EHL Modeling of Non-homogenous Material and Statistical Numerical Modeling of Sub-surface Initiated Spalling in Bearing Contacts

Farshid SADEGHI

School of Mechanical Engineering,
Purdue University, West Lafayette,
IN 47906, USA

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In this presentation an approach is described to include the effects of material inhomogeneity on EHL contact and statistical modeling of Sub-Surface Initiated Spalling in Bearing Contacts. Here, a new approach based on a discrete material representation is presented that simulates this inherent material inhomogeneity and randomness. The material domain is formed by an assemblage of micro-elements that are constrained to each other through fictitious fibers, forming inter-element joints. Two levels of randomness are considered: (1) the topological randomness due to geometric variability in the material microstructure and (2) the material property randomness due to non-uniform distribution of properties throughout the material. A damage mechanics model is introduced in which there is progressive degradation of material properties with contact cycling. The model is applied to the inter-element fibers to study damage evolution in each joint under contact loading. A joint is assumed to fail upon accumulation of a critical damage state after a certain number of load cycles, initiating a micro-crack. The crack initiation location is found to vary for each material domain. However, the depths of crack initiation are found to be consistent with experimentally observed sub-surface cracks. The micro-cracks coalesce into dominant cracks with continued cycling and propagate to the bearing surface to form a spall. The propagation phase of the crack is modeled using a chain of joints (damage zone) that have failed. The computed crack trajectories and spall profiles are found to be consistent with experimental observations.

Biography

Farshid Sadeghi joined the School of Mechanical Engineering at Purdue University in 1986 and founded the Mechanical Engineering Tribology Laboratory (METL) after he received his Ph.D. from North Carolina State University. His research interest include: tribology, fatigue, fracture surface science, and micro-electro-mechanical-sensors for tribological applications. He has authored and/or co-authored more than 75 archival publications in leading international journals and has given over 200 presentations at various conferences, industries and governmental agencies.

Professor Sadeghi has graduated 55 PhD and M.S. Students, currently serving as the chairman of 12 Ph.D. and 1 M.S. students. He has chaired, co-chaired and/or organized over 50 sessions at international conferences and served as the chairman of the 2000 ASME Tribology Conference in Seattle, Washington. Professor Sadeghi has received more than 14 million Dollars in research grants and contracts from governmental agencies and industrial companies.

Honors and Awards:

- 2007 Best Paper award for the paper entitled "Deterministic Modeling of Honed Cylinder Liner Friction," from the Society of Tribologists and Lubrication Engineers (STLE) Tribology Transactions, Vol. 50, No. 2, pp. 248-256 Co-authored by Bolander N. W. and Sadeghi, F. 2007
- Elected Fellow of American Society of Mechanical Engineers (ASME) - -2006
- 2005 Best Paper award for the paper entitled "Lubrication Regime Transitions at the Piston Ring - Cylinder Liner Interface" from The Institute of Mechanical Engineers (IMEchE) Journal of Tribology, Vol. 219, pp. 19-31 Co-authored by Bolander, N. W., Steenwyk, B., D., Sadeghi, F. and Gerber, G. R.
- H.L. Solberg Best Teaching Award, School of Mechanical Engineering, Purdue University - 2004
- Elected Fellow of Society of Tribologists and Lubrication Engineers (STLE) - -2004
- Society of Tribologists and Lubrication Engineers (STLE) 1996 Edmund E. Bisson Award given for the most outstanding written contribution to the Lubrication Engineering Journal, Co-authored by Sadeghi, F., Anderson, D.C., and Ortiz, J.
- The Society of Automotive Engineers (SAE) 1992 Ralph R. Teetor Educational Award in recognition of significant contribution to teaching, research and student development.
- The American Society of Mechanical Engineers (ASME) 1991 Burt L. Newkirk award for the paper "Thermal Elastohydrodynamic Lubrication of Rolling/Sliding Contacts"
- The Jacob Wallenberg Foundation Grant, Royal Swedish Academy of Engineering Sciences, 1987
- Member of National Engineering Honor Society (TAU BETA PI)
- Member of the Scientific Research Society (ΣX)