Critical Plane Analysis of Rubber Bushing Durability Under Road Loads

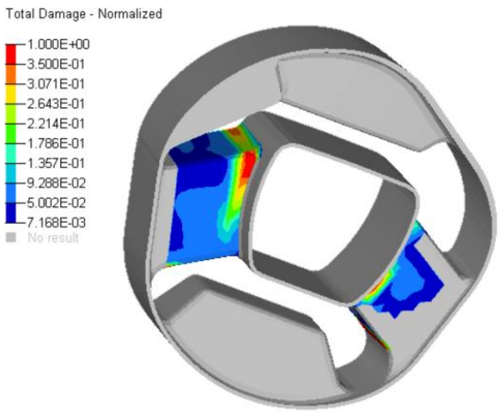
Kevin P. Barbash
General Motors, Warren, MI

William V. Mars
Endurica LLC, Findlay, OH

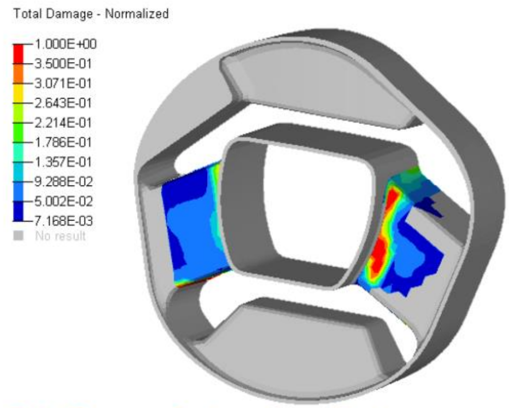
ABSTRACT. We demonstrate here an accounting of damage accrual under road loads for a filled natural rubber bushing. The accounting is useful to developers who wish to avoid the typical risks in development programs: either the risk of premature failure, or of costly overdesign. The accounting begins with characterization of the elastomer to quantify governing behaviors: stress-strain response, fatigue crack growth rate, crack precursor size, and strain crystallization. Finite Element Analysis is used to construct a nonlinear mapping between loads and strain components within each element. Multiaxial, variable amplitude strain histories are computed from road loads. Damage accrues in this reckoning via the growth of cracks. Crack growth is calculated via integration of a rate law from an initial size to a size marking end-of-life. Multiaxiality is addressed via Critical Plane Analysis, in which damage accrual is computed for all potential crack plane orientations, prior to selecting the most critical orientation and its associated life. Variable amplitudes in the energy release rate history are considered via the application of rainflow counting, which is applied on each potential plane during the critical plane search. The analysis produces estimates of life for each element in the finite element model. These are visualized to identify bushing life and failure mode. Also, the analysis produces a diagnostic database enabling damage sources to be identified with respect to time, space, and orientation, and giving various details of the micromechanics of damage accumulation.

Citation: K. P. Barbash and W. V. Mars, “Critical Plane Analysis of Rubber Bushing Durability under Road Loads”, No. 2016-01-0393, SAE Technical Paper, 2016. https://doi.org/10.4271/2016-01-0393

This is a synopsis. See citation source for full paper.



Total Damage Contour (front view)



Total Damage Contour (rear view)

Observed bushing failure mode (front view)

Observed bushing failure mode (rear view)

This is a synopsis. See citation source for full paper.