Testing Brief

Measuring the Cutting Resistance of Elastomers

Kurt Miller, Axel Products, Inc.

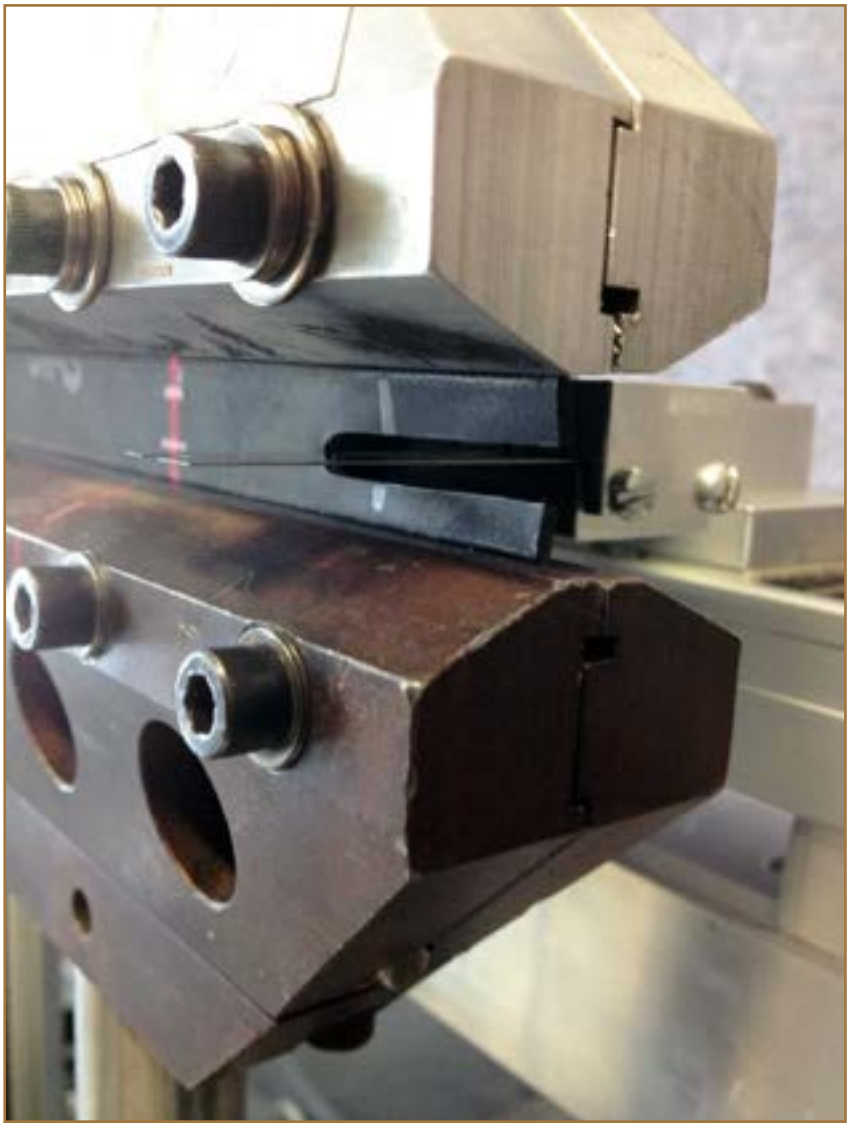

Figure 1, Sharpened Blade Contacting a Pre-strained Specimen

Introduction

Cutting resistance is measured by applying a sharp blade against a pre-strained elastomer specimen while observing the force required to cut into the elastomer. The cutting resistance force can be used directly to evaluate and compare materials, and to provide information about minimum requirements for crack growth. The experiment that we perform at Axel Products is a modern version of the experiment performed by G.J.Lake and O.H. Yeoh referenced in the International Journal of Fracture 14, 509 (1978).The experiment was re-discovered by Will Mars of Endurica when he was seeking an efficient and repeatable procedure for estimating fatigue endurance limits for elastomers.

The resulting data may also be used as part of an intrinsic energy calculation to predict an elastomer's fatigue endurance limit. This limit marks the point below which cyclic loads may be endured indefinitely without incurring damage.

The resulting measurements are the forces required to cut the elastomer at set pre-strained levels.

The Test Method
A rectangular specimen, approximately 150 mm x 20 mm, is cut from an elastomer sheet that is between 1-2 mm thick. The specimen is gripped in a tensile test instrument along the long edge such that 10-12 mm of material remains between the grip edges. This specimen is often referred to as planar tension or pure shear specimen.

Specimen Pre-cycling
The specimen is slowly cycled 5 times to a set strain greater than the future cutting force pre-strains to minimize the effects of softening.

Specimen Pre-cut
A pre-cut of approximately 25 mm is made on one side of the specimen.

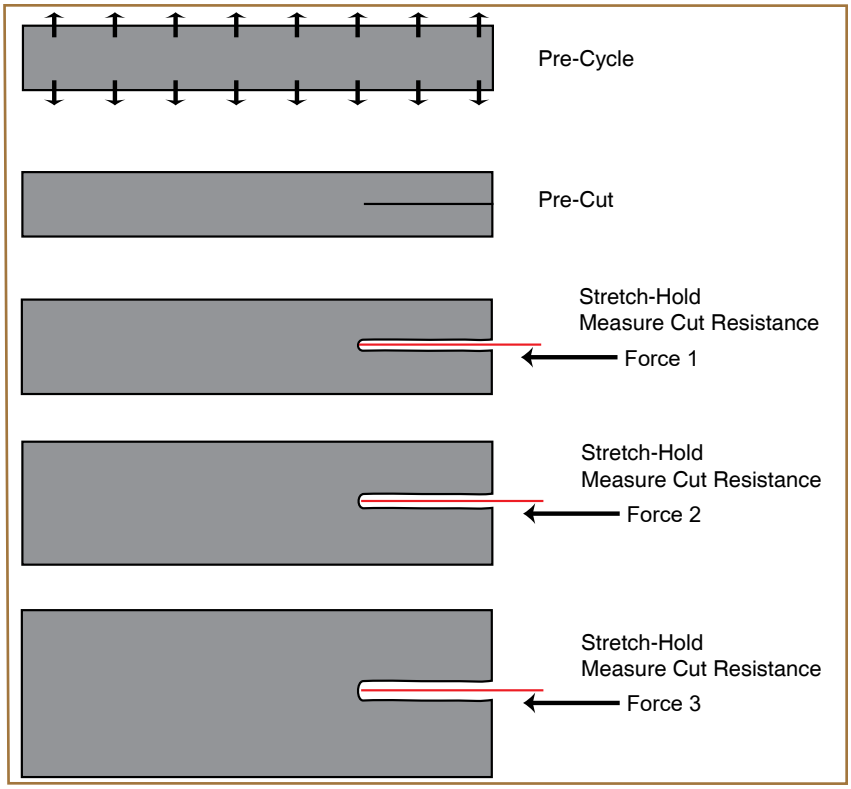

Figure 4, Cutting Resistance Schematic

Stretch-Hold-Cut
The specimen is stretched to the first pre-strain and allowed to relax for approximately 1000 seconds. A highly sharpened blade (microtome blade) is then very slowly brought into contact with the pre-cut surface. The force required to cut into the elastomer is measured. The blade speed is typically less than 1 mm/minute.
The cutting blade is retracted and the elastomer is further stretched to a larger pre-strain followed again by a 1000 second relaxation and additional cutting measurement. This process is typically repeated at 3 pre-strain levels.

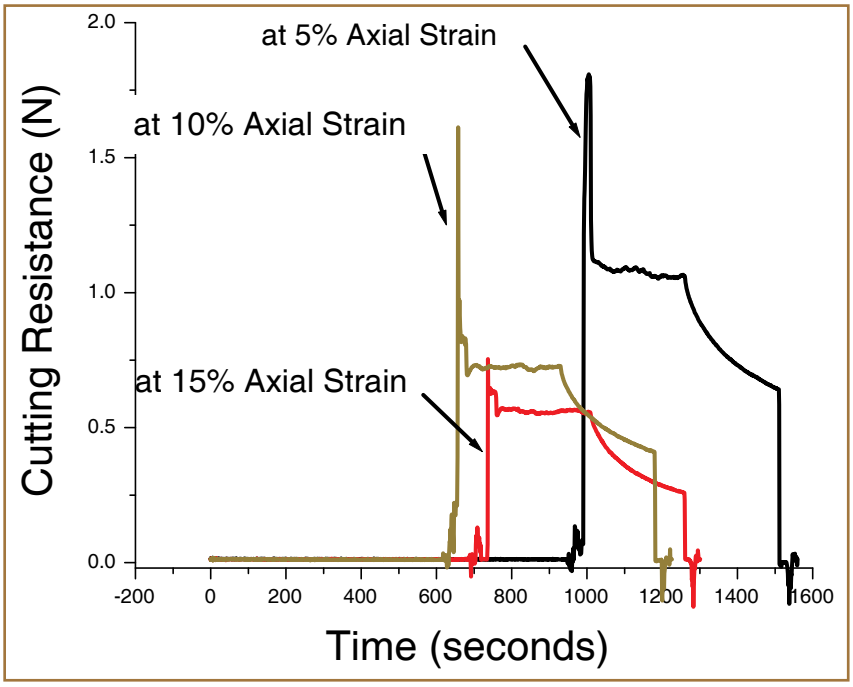

Figure 2, Cutting Resistance Data

References

Lake, G. J., & Yeoh, O. H. (1978). Measurement of rubber cutting resistance in the absence of friction. International Journal of Fracture, 14(5), 509-526.

Lake, G. J., & Lindley, P. B. (1965). The mechanical fatigue limit for rubber. Journal of Applied Polymer Science, 9(4), 1233-1251.

Lake, G. J., & Thomas, A. G. (1967). The strength of highly elastic materials. Proceedings of the Royal Society of London. Series A. Mathematical and Physical Sciences, 300(1460), 108-119.

Mars, W. V., Lecture 6 - Intrinsic Strength Module, Characterizing Elastomer Fatigue Behavior, Endurica LLC, Findlay, Ohio, 2015.

Mars, W. V., Characterizing Elastomers for Fatigue Life Prediction, Rubber World, 251(6) 34-38, 2015.

Figure 3, Complete Cutting Resistance Instrumentation

For more information, visit www.axelproducts.com.

Axel Products provides physical testing services for engineers and analysts. The focus is on the characterization of nonlinear materials such as elastomers and plastics.

Data from the Axel laboratory is often used to develop material models in finite element analysis codes such as ABAQUS, MSC.Marc, ANSYS, Endurica and LS-Dyna.

Axel Products, Inc.

2255 S Industrial
Ann Arbor MI 48104
Tel: 734 994 8308
Fax: 734 994 8309
info@axelproducts.com

axel
physical testing services