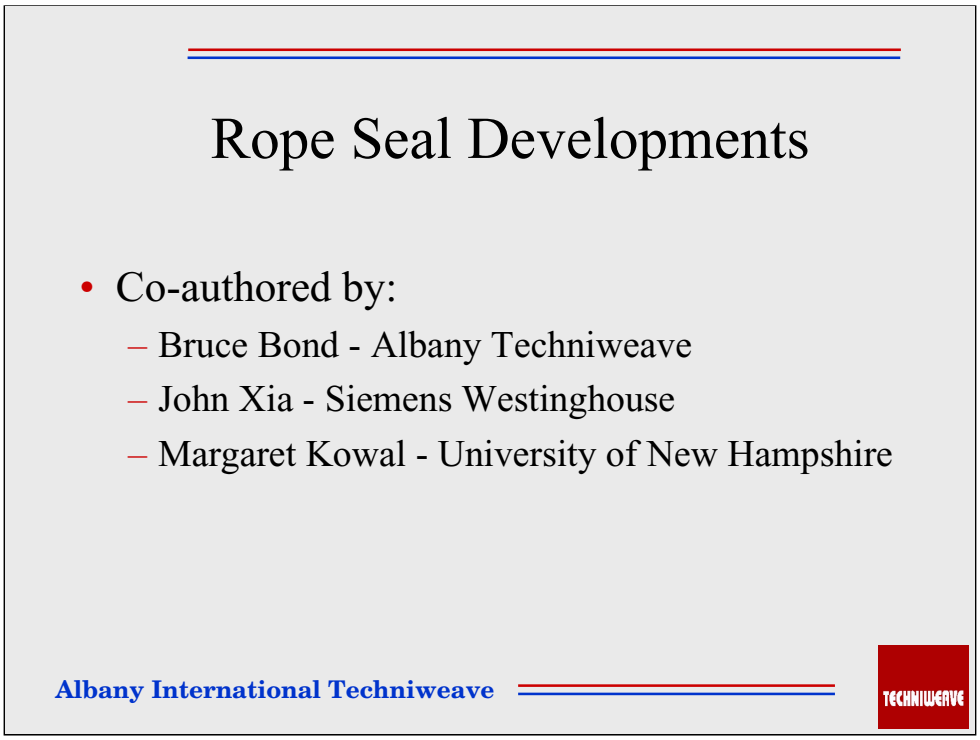
ROPE SEAL DEVELOPMENTS

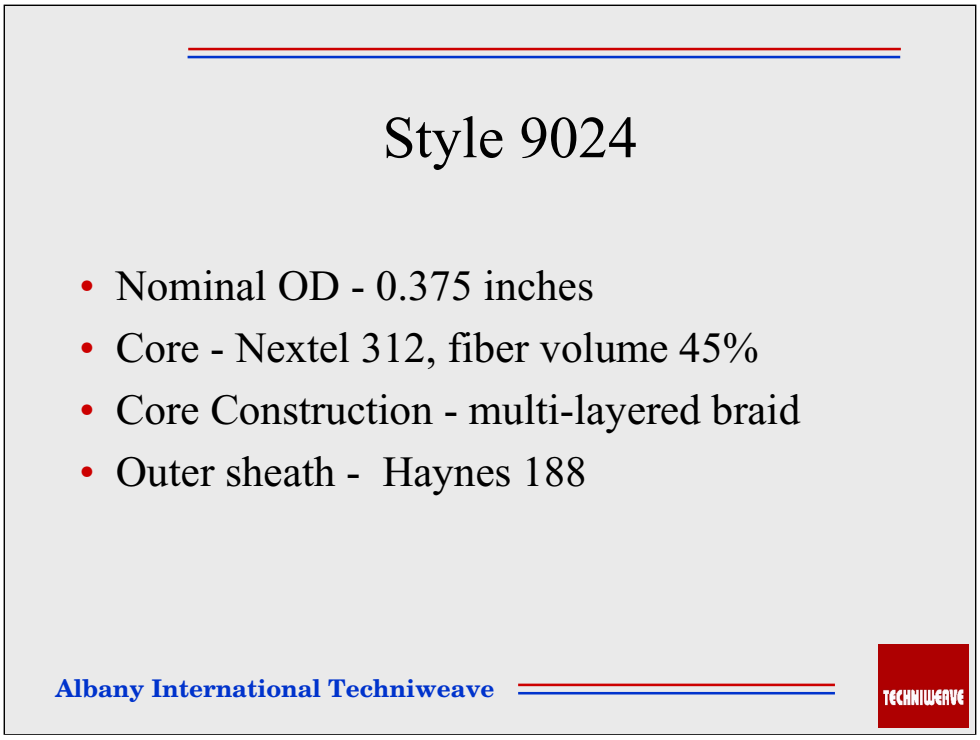
Bruce Bond
Albany International Techniweave, Inc.
Rochester, New Hampshire

John Xia
Siemens Westinghouse

Margaret Kowal
University of New Hampshire
Durham, New Hampshire



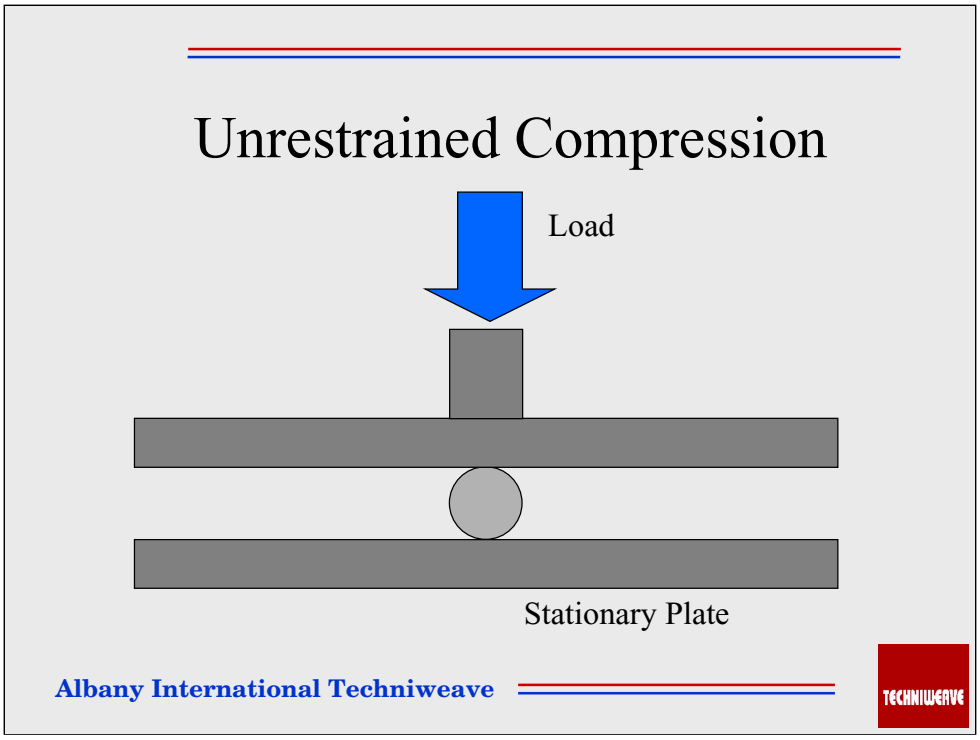
The work presented here includes information gained from a number of experiments conducted on a standard Albany Techniweave Style 9024 rope seal. The information contained herein is shared with the permission of Siemens Westinghouse. A special note of appreciation goes to Margaret Kowal of the University of New Hampshire for her assistance in this effort. Margaret is in her second year of a Masters in Chemical Engineering at UNH and is funded by a joint program between the University of New Hampshire and Albany Techniweave.



The AIT Style 9024 is a hybrid rope seal consisting of a multi-layered braided core of Nextel™ 312 yarns with an overbraid of Haynes™ 188 wire. The wire protects the fragile ceramic yarns in abrasive environments.

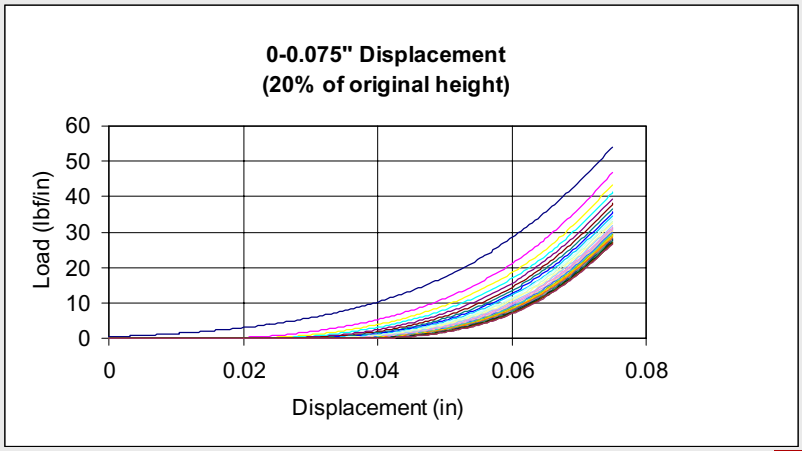
Experiments Conducted

- Unrestrained compression
- Compression in grooves to fixed volumes (105% of original seal x-section)
- Compression in .360 wide groove with varying depths to fixed max loads



Unrestrained compression was conducted between two flat plates using an Instron™.

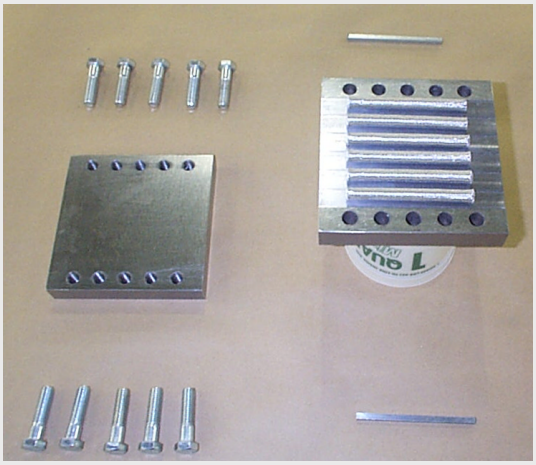
Typical 30 Cycle Load Curve



Albany International Techniweave

Cyclical loadings to a fixed displacement show a decreasing rate of change in the load required and the amount of recovery.

Compression and Impregnation

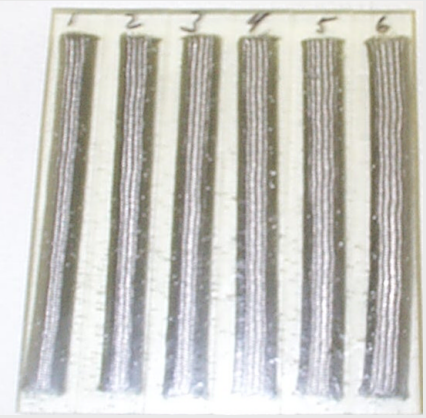


Albany International Techniweave

TECHNIWEAVE

A fixture consisting of a plate with grooves and a smooth plate was used to compress six seal samples between 5 and 30 percent of the original seal diameter.

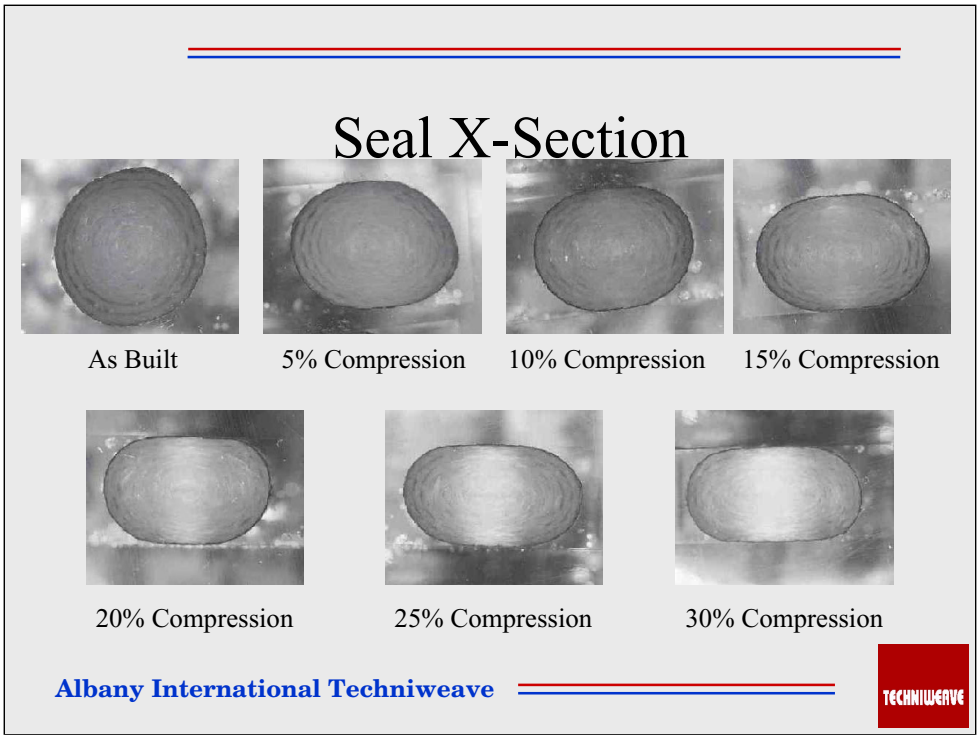
Seal Shape Captured in Epoxy



Albany International Techniweave

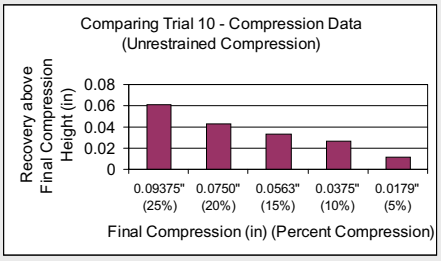
TECHNIWEAVE

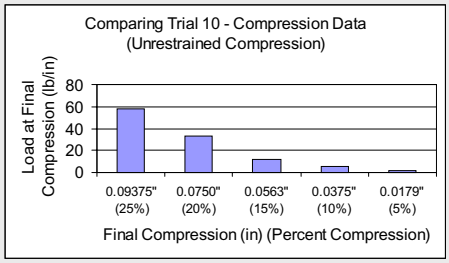
The seals were imbedded in an epoxy resin to fix their shape.



The potted seals were sectioned, photographed and the cross sectional area measured. The seals exhibited a decrease in cross section with increasing compression and hence an increase in fiber volume. In contrast, elastomeric seals would have a constant cross section.

Comparison of 10th Cycle Curves





Albany International Techniweave

In some instances a rope seal will be required to seal between two flat surfaces. The above graphs show the recovery and loads as a function of the percent compression as based on the original diameter.

Compression to Fixed Volumes (0.117 sq. in)

Width	0.371”	0.396”	0.495”	0.446
Depth	0.313”	0.296”	0.235”	0.262”

*Note, photos are for demonstration purposes only; testing was performed one seal at a time

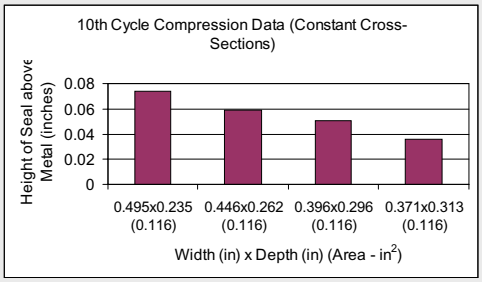
**Note, 1st set of grooves are slightly off scale from 2nd set of grooves in this slide

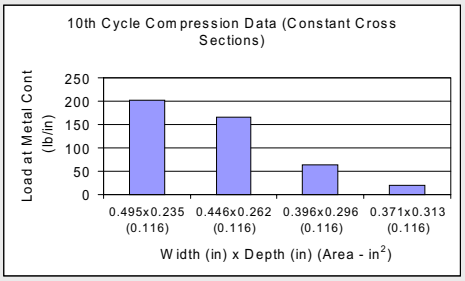
Albany International Techniweave

TECHNIWEAVE

Seal samples were subjected to repeated compressions in grooves with constant cross section and varying dimensions.

Comparison of 10th Cycle Curves

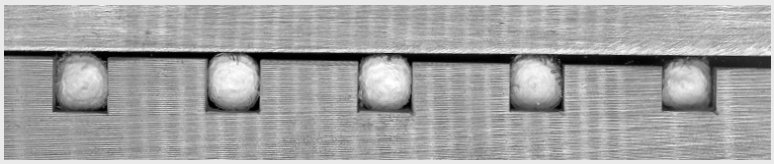




Albany International Techniweave

In some instances the anticipated loads would be sufficient to ensure metal to metal contact. The graphs above show the recovery of the seal and the loads required to make metal to metal contact for various configurations where the cross section of the groove has been held constant.

Compression with Changing Volume (Constant Width)



Width:	0.360”	0.360”	0.360”	0.360	0.360”
Depth:	0.356”	0.338”	0.319”	0.300”	0.281”
Area:	0.128 in^2	0.122 in^2	0.115 in^2	0.108 in^2	0.101 in^2

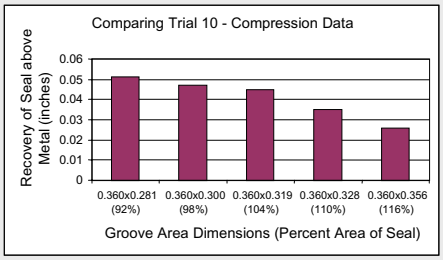
*Note, photos are for demonstration purposes only; testing was performed one seal at a time

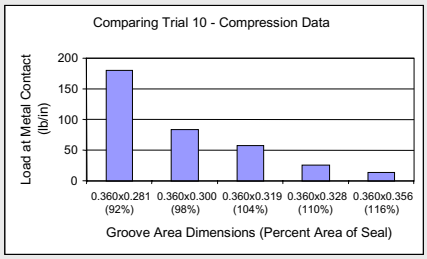
Albany International Techniweave

TECHNIWEAVE

In certain applications it is desirable to place the seal in a groove which is slightly narrower than the diameter of the seal to facilitate installation and retention during assembly. A family of curves can be established using different loads per linear inch and various groove depths..

Comparison of 10th Cycle Curves

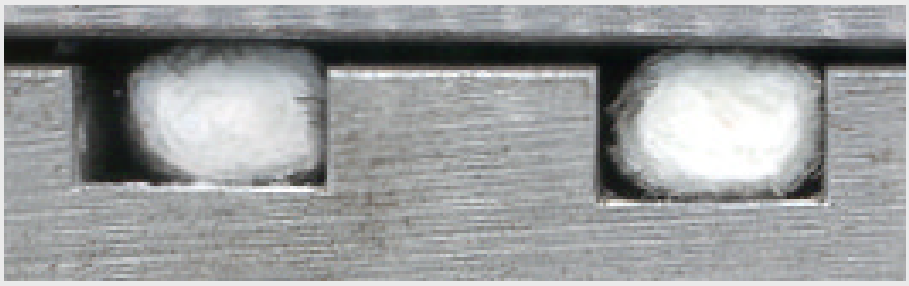




Albany International Techniweave

In some instances the anticipated loads would be sufficient to ensure metal to metal contact. The graphs above show the recovery of the seal and the loads required to make metal to metal contact for various groove depths where the width is held to a 0.360 inches.

Compression to a Fixed Load

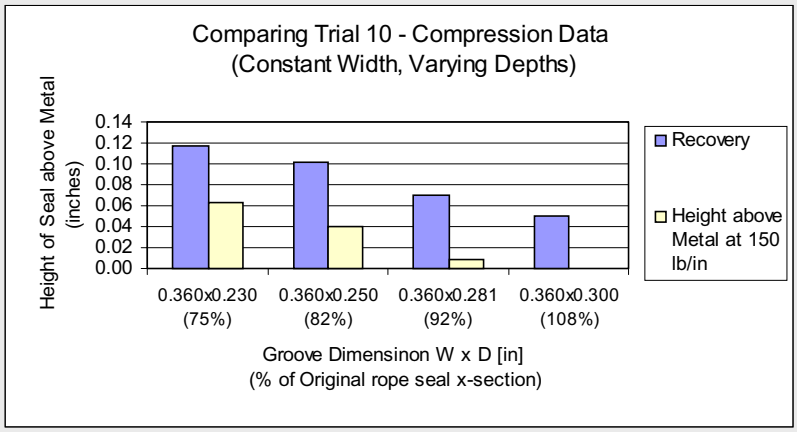


*Note, photos are for demonstration purposes only; testing was performed one seal at a time

Albany International Techniweave

The seals were compressed using various grooves where the load was limited to certain maximums as measured in pounds/inch of seal length.

Comparison of 10th Cycle



Albany International Techniweave

This graph shows the recovery and the final height above the metal surface for various groove configurations where the maximum load was 150 lb./linear inch.

Summary

- Cyclical compressions appear to approach a stable load / deflection curve
- Resiliency is a function of both the amount of compression and the groove configuration
- Specific applications may require specific testing

Future Work

- Room temperature leak testing
  - Fixed groove, varying amounts of compression
  - Effect of architecture on leakage
- Testing of other seals
  - .050” - 0.500”
  - Nextel-312, 440, 550, 610, 710

The next area of investigation is to evaluate the effect of compression and architecture on leakage at room temperature. The work will be extended to include our other standard seals and a wide range of potential fibers and architectures.