

Leighton Burt

*Elastic, Plastic or Bust: Investigating Yield Strength of Butyl Rubber Tubes*

Automotive inner tubes are commonly used for a variety of recreational activities, i.e. snow sledding or river tubing because they are reasonably durable, slide fast, and are relatively inexpensive. This project examined an inner tube's stress/strain relationship when inflated to determine a recommended inflation value for recreational use.

A water manometer was constructed to measure the relatively low pressures (<3 psi) for the experiment. Three inner tubes of identical make and model were tested at eight different outer circumferences. Thirty six surface measurements were also collected for a total of 288 data points per tube.

By the third outer circumference increment for all tubes, air pressure (11.4 kPa, 1.7 psi) within the tube stopped increasing, even though the tube continued to deform and expand as more air was added. The gauge air pressure increased by 132% from the starting pressure and then leveled for the last six increments, differing by only 6.01%. As the outer circumference increased, the inner circumference initially decreased in size by 3.81% then began expanding as the internal air pressure remained constant within experimental error.

Comparing the toroidal strain with the poloidal strain, the material stretched the most in the outer poloidal sections which indicates that failure will most likely occur along the outer circumference of the tube.

The data shows the tube material reaches its yield point at approximately 11.4 kPa (1.7 psi). At this point the tube material begins to deform plastically and loses ductility. Recreational use requires inflating the inner tube to its yield strength which means the tube will eventually fail.