Quantification of mechanical behavior of rat tail under compression_Dataset

Introductory Information

The development of vibration-induced finger disorders is likely associated with combined static and dynamic responses of the fingers to vibration exposure. To study the mechanisms of these disorders, a new rat-tail model has been established to mimic the finger pressure and vibration exposures. However, the mechanical behavior of the tail during compression needs to be better understood to improve the model and its applications. The purpose of the current study was to investigate the static and time-dependent force responses of the rat tail during compression. Compression tests were conducted on male Sprague-Dawley cadaver rat tails using a micromechanical testing system at three deformation velocities and three deformation magnitudes. Contact-width, and the time-histories of force and deformation were measured. Additionally, force-relaxation tests were conducted and a Prony series was used to model the force-relaxation behavior of the tail.

Methods Collection:

Specimen preparation

- Eighteen male Sprague-Dawley cadaver rat tails with an average tail length of 172 mm were used for this study.
- The tails were obtained from control groups that were a part of several inhalation studies and all procedures performed on the animals were approved by the NIOSH Morgantown Animal Care and Use Committee in those studies.
- The tails were collected after the rats were euthanized, put in aluminum foil to limit air/water exposure, then put on ice, and immediately after were delivered to our mechanical testing lab for experimentation.
- The tails were kept at 5° C to avoid the onset of rigor mortis and freezing, and were removed an hour prior to testing to adjust to room temperature which was checked using a thermometer.
- All testing took place on a 7.5-mm-diameter section for each tail, which was measured and marked prior to testing to ensure the tail diameter was consistent for all tests.

Experimental set up and testing

- All compression testing was completed using the Mach1Motion micromechanical system equipped with a displacement sensor with a resolution of 0.5 μm and a 98 N (10 kg) load cell with a resolution of 4.90 mN (500 mg). Max sampling rate of machine was 50 Hz.
- During testing each tail was only used once and the tails were placed in a rigid plastic base platen that was 2-3 times that of the tail to ensure it did not touch the sides during compression (unconfined).
- A platen (57 mm in length and 25 mm in width) was attached to the indenter, which was used to compress the tail.
- For all compression tests the deformation magnitude and deformation velocity were specified using the machine, and the time histories of force and deformation were measured.

Design of compression tests

- The indenter platen was centered over the 7.5-mm-diameter-loaction on the tail and the indenter platen was applied directly to the top surface of the rat tail during the compression testing.
- Three tails were tested at each of the three selected deformation velocities (0.15 mm/s, 0.05 mm/s, and 0.015 mm/s), and all tails were compressed to a deformation magnitude of 1.875 mm (25% compression ratio).
- A pre-conditioning compression cycle process was used to obtain a steady state, a total of ten compression cycles were completed, and the 9^{th} cycle was used for data analysis as it was consistently the most representative of the steady state for all tails tested.
- For the fastest deformation velocity (0.15 mm/s), an 11^{th} cycle was completed for the three tails in which an 11-minute hold was executed immediately after the deformation to evaluate the force-relaxation response of the tail.

Contact width testing

- For the contact width testing three tails were tested at each of the three deformation magnitudes (0.75 mm, 1.35 mm, and 1.875 mm or 10%, 18%, 25% compression ratio, respectively), all at a deformation velocity of 0.015 mm/s.
- To determine the contact width of the tails during the compression tests a light coat of baby oil and then baby powder was applied to tail.
- After the oil and powder was applied to the tail a plexiglass piece identical in size to the indenter platen was carefully placed on top of the tail.
- The indenter platen, the plexiglass, and the 7.5-mm-diameter-location were all centered over one another and then the tail was compressed.
- After the compression test the baby powder left an accurate and detailed outline of the tail on the plexiglass piece that had been placed on top of the tail.
- The plexiglass piece was then careful removed and photographed with a reference scale in frame.
- The contact widths were then measured and recorded using the pictures taking during testing.

Citations – Publications based on the dataset

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