Cornell University
Laboratory for Elementary-Particle Physics

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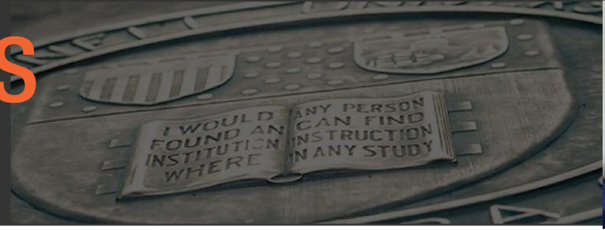
SR CCS 2013



Summer Research for Community College Students – 2013

Development of an x-ray computed tomography instrument

The Experiment

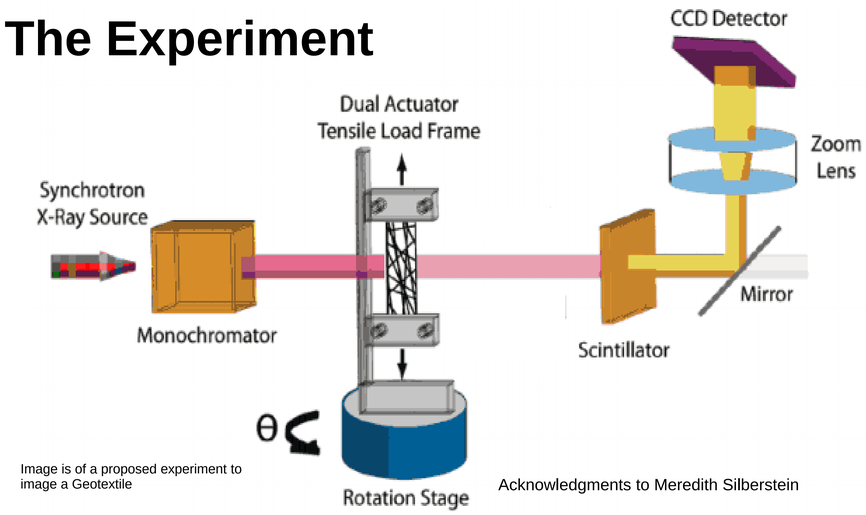


Image is of a proposed experiment to image a Geotextile

Acknowledgments to Meredith Silberstein

The experiment above is to test the tensile strength of Geotextiles. Using the x-rays from CHESS and computed tomography we can see how the fibers move when stretched.

The x-ray beam will pass through the textile and hit a scintillator, and then fluoresce light that we can magnify and image using a detector. We can take many images and then turn it into a 3-D model.

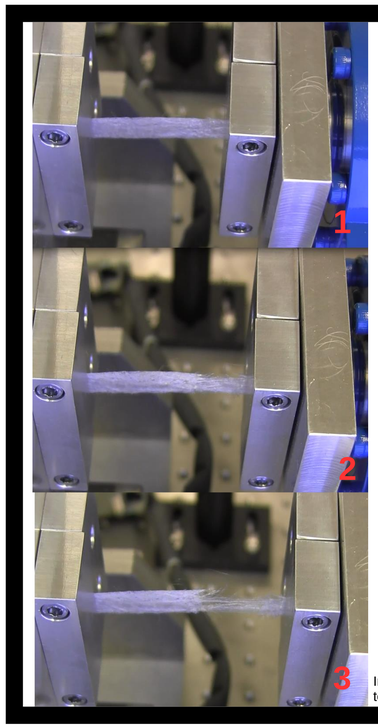
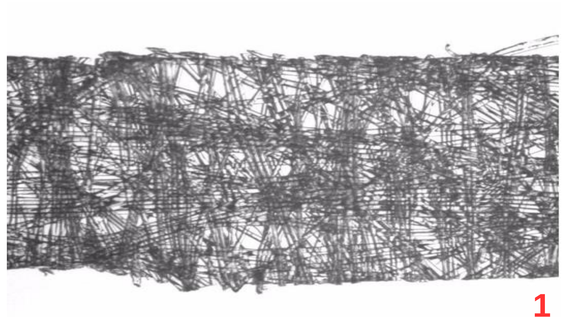


Image to the left is snapshots from a video of tearing the Geotextile in the prototype stages



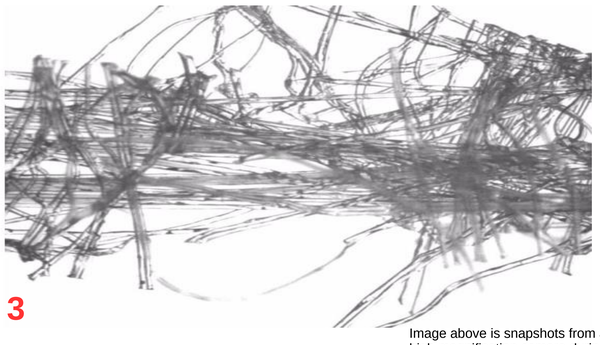


Image above is snapshots from a high magnification camera during a test stretching the textile.

Testing

Using a high magnification camera we can image small enough to learn about how the fibers move when stretched.

Starting at 0 inches stretched, (1) the textile is pulled to a half inch separated (2) and then to 1 inch stretched (3) where another camera image is taken.

We can see how the fibers broke, stretched and frayed in the before and after shot. Imaging in a x-ray beam will give us higher quality and 3-D images, but will require more precision.

The Prototype

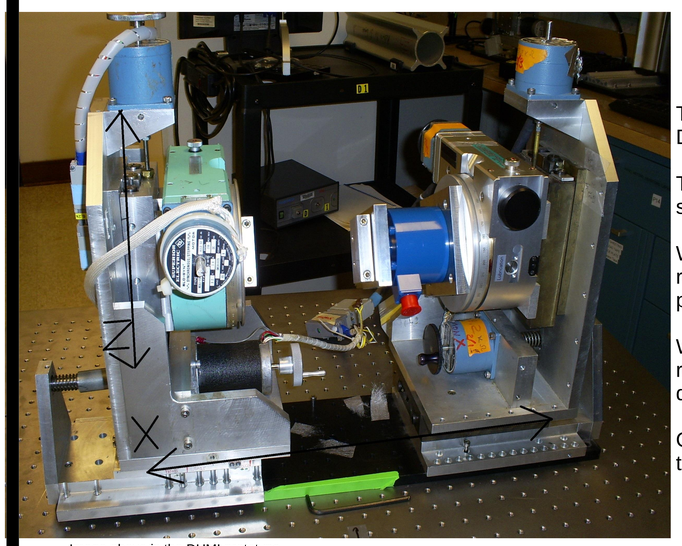


Image above is the DUMI prototype used to stretch and spin a Geotextile.

The prototype we came up with is named DUMI (Dummy) (DUal Motor Imaging)

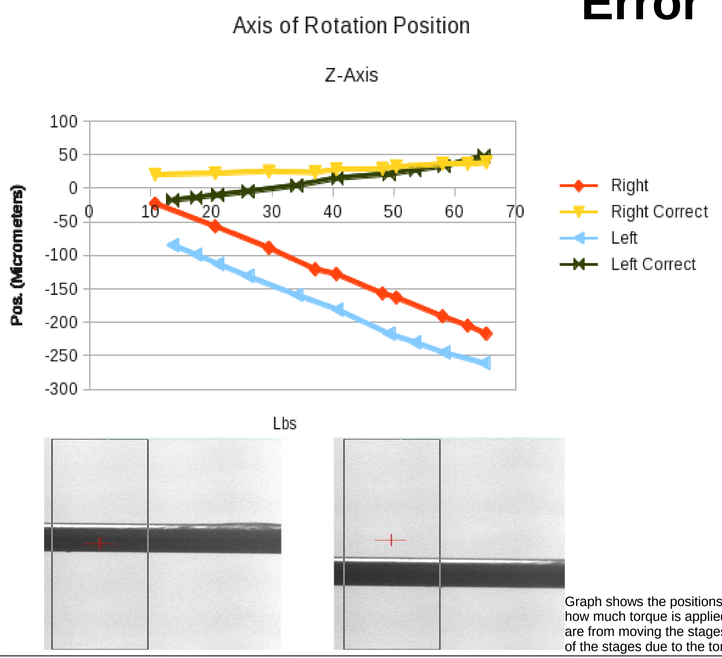
The textile needs to be rotated for imaging and stretched to see how the fibers break.

We decided on a horizontal set up with 4 motors: 2 rotational and 2 translation, left and right, to spin and pull the sample. And added 2 Z axis for alignment

Wiring and calibrating a load cell allows us to reliably measure the tension on the textile depending on how far we stretch the material.

Our design allows us to measure stretched distance, tensile force, and images the fiber positions

Error



Graph shows the positions of the rods seen to the left based on how much torque is applied to the stages. The corrected data sets are from moving the stages in the Z direction to correct the bending of the stages due to the torque.

There are many sources of error in our experimental setup due to alignment and motor imprecision.

The biggest error comes from the tensile force exerted on the motor stages.

The textile being stretched exerts some torque on the stages which causes some Z axis (up/down) deflection.

As seen on the left when force is applied on the stages the center of rotations shift downwards.

If our sample is moved down enough then it will not be in the x-ray beam, and therefore not imaged.

By using SPEC we can calculate the force and correct the Z deflection by moving each rotation stage up or down back into alignment.

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Any opinions, findings, and conclusions or recommendations expressed in this work are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.