Teacher Tech Brief

Tensile Strength Test Strand

Context

The different materials used in constructing the Space Shuttle EMU were chosen because they each featured properties deemed desirable for spacewalking. Depending upon their intended purpose, material may have to withstand tears, punctures, temperature extremes, bending, abrasion, or any combination of the above.

Purpose

This test stand measures materials for their resistance to tensile (stretching) forces.

Principle

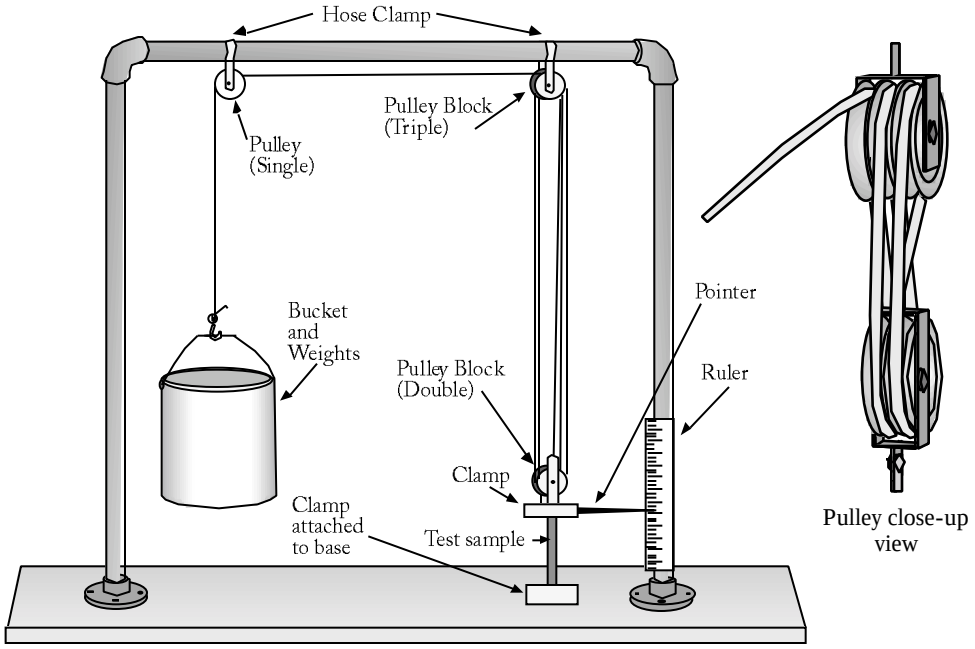
Using the mechanical advantage of a pulley setup, tensile forces are exerted on test samples until they break.

Materials and Tools Checklist

- ☐ Wooden base (6" x 1" x 4')
- ☐ Threaded iron pipe (1 pc 3/4" x 2') (2 pcs 3/4" x 3')
- ☐ Pipe elbows (2 pcs)
- ☐ Pipe flanges (2 pcs)
- ☐ Screws for flanges
- ☐ Pulley (1 single)
- ☐ Pulley block (1 double, 1 triple)
- ☐ Cord for pulleys
- ☐ Clamps (2)
- ☐ Metric Ruler
- ☐ Pointer (stiff wire)
- ☐ Hose clamps (2 pcs)
- ☐ Lead weights (25 kg)
- ☐ Bucket
- ☐ Screwdriver
- ☐ Pipe wrench
- ☐ Materials to be tested
- ☐ Eye Protection

Operation

Obtain different fabric samples from remnant tables at fabric stores. Also ask students to bring in samples with which to work.Cut the material to be tested into a rectangular strip 1 centimeter by 10 centimeters in size.The sample is held between two clamps as shown in figure 1. Place a small number of lead weights in the bucket to counterbalance the weight of the clamp and pulley assembly so that the sample material is held upright. Record the position of the wire pointer on the ruler. This is the zero force measurement. Gradually add measured weights to



the bucket. The mechanical advantage of the pulley arrangement magnifies the actual pull (tensile force) on the sample five times. Record the tensile force (the weight in the bucket multiplied by five) and the position of the pointer. The position of the pointer indicates how much the fabric stretches as the force increases. Add more weight and record the data. Continue this process until the sample breaks or you run out of weights. Create a graph to demonstrate the performance of the material.

Tips

- An empty metal gallon-size paint bucket can be used to hold the lead weights.
- Used wheel-balancing lead weights can be obtained free or for little cost at tire stores.
- In some materials, tensile strength varies with the direction the force is exerted. Compare cut crosswise to the grain and on the bias.
- For very strong fabrics (e.g. Kevlar®) test a narrower strip or even single strands and extrapolate the results to the force a one-centimeter wide piece could withstand.
- The test stand can be modified for other materials tests.
- Students should wear eye protection when operating the apparatus.
- Details on how to attach the clamps to the apparatus have not been provided because of the variety of clamping devices that could be used. Students building the apparatus will have to determine how this is done.

Extensions

- Contact manufacturers of "high-tech" fabrics and fibers for specification sheets on the properties of their products. Some manufacturers may have web sites on the Internet. Conduct an Internet search using terms such as Kevlar® and Nomex®.
- Visit a sail maker's shop to learn about materials being used for sail construction and how fabrics are stitched together for maximum strength.
- Learn about how fabrics are manufactured and how different properties are achieved through fiber choice, weaving techniques, and coatings. Check for videotapes in school video catalogs.