STRENGTH OF PAPER

I have been involved in making artist's books for a little over a year now and I enjoy my newly found hobby.

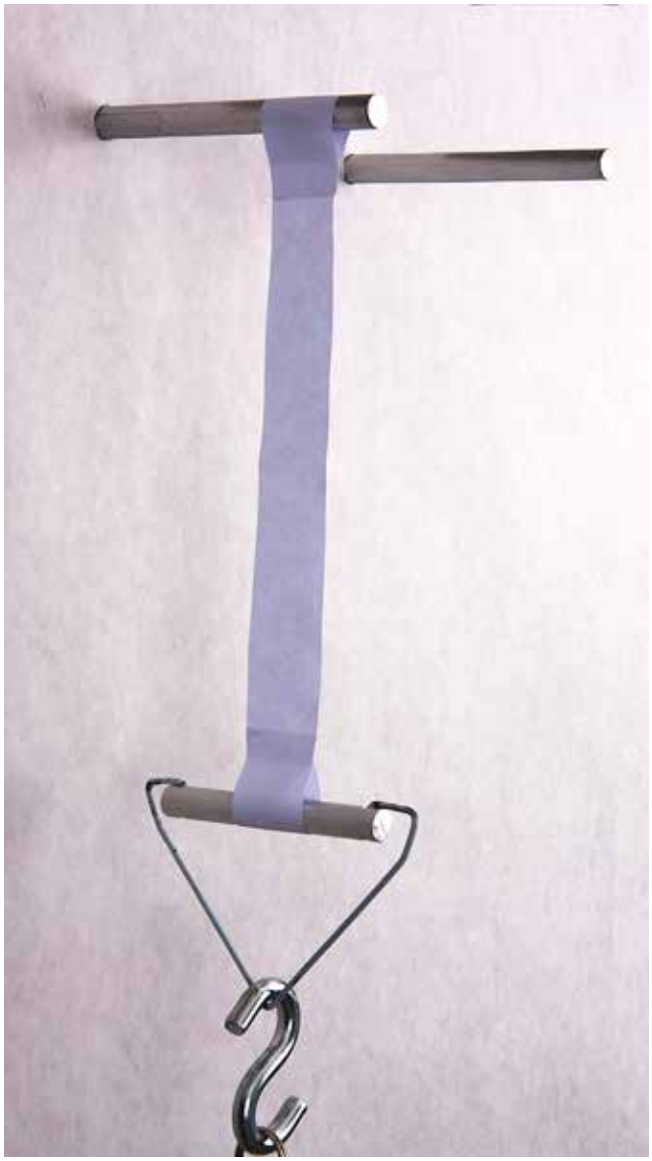
Normally I approach the designing and making of artist books systematically. I like to understand why something should be done in a certain way and not differently.

I started my career many years ago in a chemistry lab, and then switched to industrial design, and as a result of studying both disciplines, I am used to and follow the scientific method of observation, hypothesis, theory and testing, when I create something.

Recently I attended a workshop in which the west coast representative of a Japanese paper company ***Washi Papers*** demonstrated among other things the use of ***konnyaku***, a powder made of the root of the Devil's Tongue plant. When mixed with water the powder turns into a jelly which can be brushed onto papers to make the stronger. We had a chance to experiment with this jelly onto different papers. This intrigued me and I decided to test if the claim is true. So, I obtained the powder and proceeded to devise a simple paper strength testing instrument. Now, I need to mention that testing the properties of paper is done in professional laboratories with equipment that costs many thousands of dollars. However, all I was interested is to find out if there is a significant difference in strength between a non-treated and treated (with konnyaku jelly) paper. My "instrument" was adequate to do this job well. I must also tell you that my interest is in trying to strengthen standard, not Japanese paper.

Here at right is my ***paper testing instrument***. It consists of a metal rod (1) held tightly in a wooden frame and another free-hanging metal rod (2). Both of these rods are in the looped ends of a strip of paper (4). In addition there is a large metal can which can be filled with heavy weights (3) such as lead sinkers used by fishermen.

As long as the tests are made with the same size and kind of materials, (paper strips) it does not matter if these conform to certain official sizes. So I decided to make many strips of 11" long by 1" wide strips using standard typing paper. The ends of the strips were glued over to create a large enough loop to go over the metal rods. The ends were glued using PVA cement and let to dry overnight before using for testing.



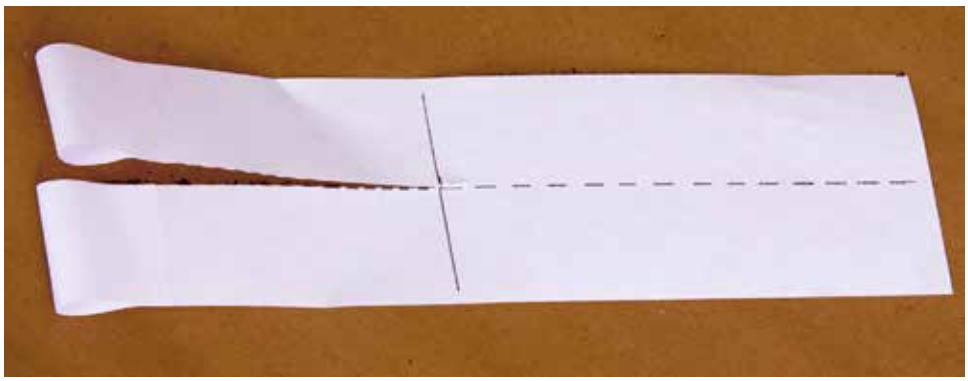
A close-up view of the strip held between the two metal rods.

So, with my instrument and strips ready, I started adding weights carefully into the can. First I put a weight which was only about half a pound. Then another half. Nothing happened. Then I put another weight of 1 lb and still nothing happened. Then I decided to be bold and continued to add 1 pound weights until I reached a total weight of 24 lbs. Wow, I could not believe my eyes! A strip of paper only one inch wide can be pulled with a force of 24 lbs without snapping apart. And then it happened, when I added another 1 lb weight, the paper snapped loudly and everything dropped down on the floor. I repeated the test with 4 additional and identical strips of paper and I obtained practically identical results in all 5 tests. And the conclusion?

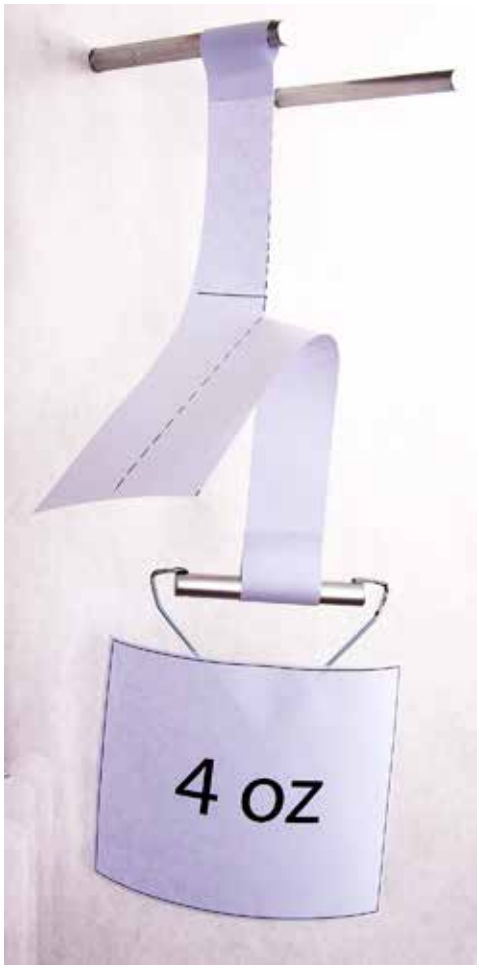
A strip of paper one inch wide will support up to 24 lbs in tensile strength (pull force) but at 25 lbs will snap in two pieces.

On right is a close-up of the strip of paper: 11" long before forming two loops at the ends by 1 inch wide.

Now was the time for the next test - tearing (or shearing) paper into two strips. The same instrument was used for this test but the sample was different. See picture below.



The sample for tearing was made of a strip of paper 2.5” wide by 11” long. It was cut at the center to half its length and two loops were formed at the ends of the cut part. Refer to the picture on the previous page.



One loop was inserted into the metal bar and the other to the free-hanging metal rod. **It took only a weight of 4 ounces to start a tear at the end of the cut, which ended up to the bottom end tearing the paper into two pieces.**

This part of the experiment was not surprising, paper behaves like many other solid materials, it has a very strong tensile strength but takes much less force to shear it.

Finally I was ready to compare the untreated paper with paper that was treated with konnyaku jelly on both sides the night before.

Alas, what a big disappointment was that!

The treated paper strips which were absolutely identical in size and shape to the untreated ones snapped with the same amount of force as the untreated ones.

This of course was not only a disappointment for me, but may be so for others who expect different behavior as a result of treatment with konnyaku.

Now is also the time to remind that I used ordinary typing paper. (Commercially made by Hammermill.) It is a standard 20 lb uncoated paper available in paper stores. The next phase of my investigation would be to repeat these experiments with Japanese papers but until then, I wish for someone else to repeat my experiment and verify my conclusions.

What is the theory behind the claim that konnyaku jelly can make paper stronger? All paper contains cellulose fibers, but in commercially made paper these fibers are shorter than in hand-made or art paper. These fibers are what give paper its initial strength. Konnyaku jelly contains starch which when applied to paper closes the gaps between the fibers and connects them. This is the theory behind using Konnyaku for stronger paper. In commercial paper other additives play this roll. These additives are either mixed with the pulp or applied on the surface of the paper.

Konnyaku jelly, right, made from powder, ready to use.