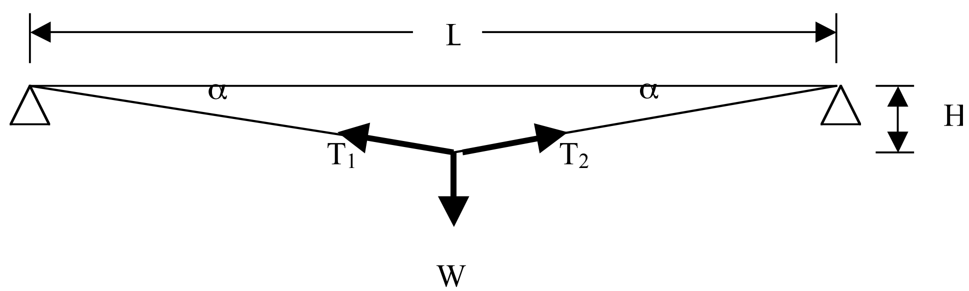
The Measurement of Warp Tension

1. Introduction

Correct and uniform warp tension is important for weaving. In the article "Precision Weaving for Overshot" [BRY] Reid Bryson presents a clever homemade device for maintaining constant warp tension during weaving. However, by using Mr. Bryson's device, a ruler, and a scale it is possible to quantify the warp tension and transfer this information to another loom or to convey it to another weaver.

2. The Physics

The physics of the Bryson tension meter can be reduced to:



Where L is the length of the warp between supports, H is the deflection of the warp with the tension meter attached, and W is the weight of the tension meter hung from the midpoint of L. From Newtonian mechanics [HAL] we have T, the magnitude[1] of the tension in the warp end equal to:

$$T = T_1 = T_2 = W / (2 * \sin \alpha)$$

Approximating sin α by H / (L/2), and substituting, we get

$$T = (W * L) / (4 * H) \quad \text{(i)}$$

Solving for the height H we get:

$$H = (W * L) / (4 * T) \quad \text{(ii)}$$

There are a few things to note. First, this tension is not the tension in the unweighted warp because we have added the weight of the tension meter. Increasing the length L and/or decreasing the weight W increases the accuracy of the measurement. Second, the

[1] Weight and tension are forces and thus are vector quantities.

measured tension varies inversely with H for a constant W.[2] Third, the measured tension will always be greater than W. Fourth, a stretchy yarn invalidates the measurement.

3. The Steps

First, construct a tension meter from Mr. Bryson's instructions. The distance from the thumbtack to the pencil mark is H. Second; weigh the tension meter on the same scale that you use to weigh your yarn. This is the weight W. Next, measure the length of the warp end either from the inside edge of the back beam to the warp thread heddle, or from the front of the shuttle race to the inside edge of the front beam, or from the back beam to the front beam for a floating selvage. This is the distance L. The tension, T, can be found from equation (i). The height H, for a given tension can be found from equation (ii).

4. Examples

Suppose I want to tell another weaver what tension I used for my project. My tension meter weighs 1.75 ounces (W)[3]. The distance between the inside of my back beam and the warp thread heddle is 14 inches (L). I hang my tension meter on one warp end half way between the back beam and the heddles. The height of the pencil mark is 1.25 inches (H). Thus, the tension (T) is:

$$T = (W * L) / (4 * H) = (1.75 * 14) / (4 * 1.25) = 4.9 \text{ ounces}$$

Another weaver tells me that they used a tension of 5.5 ounces measured by their Bryson's tension meter for their project. To find the height (H) that corresponds to a tension of 5.5 ounces for my loom and tension meter as above:

$$H = (W * L) / (4 * T) = (1.75 * 14) / (4 * 5.5) = 1.1 \text{ inches}$$

Empirical measurements have shown these results to be surprisingly good, but don't expect industrial level quality control.

5. Conclusion

Using a simple device, simple tools, and simple formulas, it is possible to measure warp tension in a quantifiable manner. This tension information can be passed on to other weavers and can be used with their looms and their tension meter to duplicate the warp tension.

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[2] This appears to be at odds with the experiment discussed by [FAN] which states that the tension varies with the square of H. Though his experiment appears to be similar, it is fundamentally different in that he is increasing the equivalent of W, and does not take into account the change in the length of the string due to the stretching of the spring balance. The tension in a warp end is certainly increased when the shed is opened.

[3] Unfortunately the English units of pounds and ounces are used for forces and mass.

6. References

[BRY] Bryson, Reid, “Precision Weaving for Overshot”, *Weavers*, issue 26, pg 39, 1994.

[FAN] Fannin, A. A., *Handloom Weaving Technology*, Revised Edition, pg 43, Design Books, New York, 1998.

[HAL] Halliday, D., Resnick, R., *Physics Parts I and II*, pp 95-97, John Wiley and Sons, New York, 1966.

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