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Part 4 Spools, 2007

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Tools and Textiles – Texts and Contexts
Research Programme

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Contents

Introduction

The experimental research described in the following report is a component of the *Tools and Textiles-Texts and Contexts* (TTTC) program directed by archaeologist Eva B. Andersson, PhD, and historian Marie-Louise Nosch, PhD. The aim of the experimental research is to investigate the function of textile tools from the eastern Mediterranean area dated to the Bronze Age using experimental archaeology. The second aim is to explore experimental archaeology as a method, including its potentials and risks. Three parts of research focusing on different questions have been performed during 2005 and 2006 (Mårtensson *et. al* 2006; 2006a; 2006b; 2007).

The Part 3, conducted in November 2006, was devoted to the investigation of function of loom weights. Four weaving experiments were made using ceramic loom weight with identical weight but different thicknesses. The loom weights were not reconstructions of specific finds. The aim was to design a standardised test of the function of loom weights which would be applicable to experiments using reconstructions in later investigations. The weight and thickness of loom weights were our focus in the test. The results demonstrated that the weight and the maximum thickness of a loom weight, as well as their internal relation, are important factors to consider when weaving on a warp weighted loom. These factors are together the key to the understanding of the textile production made with these tools. In general, thin yarn needs less tension[1] than thicker yarn; the total width of loom weights hanging in a row should be identical, or slightly larger, than the fabric to be produced. By recording measurements of both weight and maximum thickness of loom weights, it is possible to outline the kind of tabby textiles that could have been produced with a given yarn quality. Comprehensive knowledge of these elements is thus of importance when interpreting loom weights in archaeological assemblages (Mårtensson *et al.* 2007).

The results from Part 3 encouraged us to conduct further tests in Part 4, in which we applied our new knowledge. Our aim was to demonstrate examples of how reconstructed loom weights from archaeological finds could work in a warp weighted loom, considering both their weight and thickness. The aim was to give suggestions to what kind of tabby textiles are suitable to produce with specific loom weights and a given yarn quality. Secondly, we wanted to investigate further how different loom weight shapes function in a warp weighted loom. The tests were carried out by archaeologist and textile technician Linda Mårtensson.

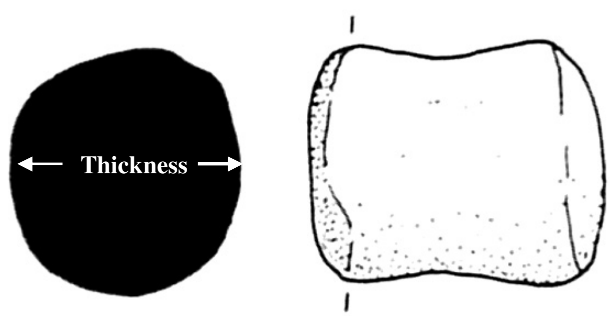


Fig. 1. Spool. Arrows show what is meant by thickness.

[1] By tension we mean the weight per warp thread needed for optimal weaving.

Part 4: Spools

The so-called spools have been object of discussion weather they can be used as loom weight (Gleba Forthcoming; Rahmstorf 2003; 2005:156), and therefore it was highly interesting to reconstruct loom weights of this shape for the tests (fig. 1). Two unfired clay spools with different thickness and weight were selected from the same context, Building 1, Room I, Pit, in Khania on Crete dated to LM IIIC (Hallager and Hallager 2000, 40-41). Based on these finds, two sets of unfired clay spools were reconstructed by ceramicists Inger Hildebrandt and Marianne Smith working at Lejre Historical-Archaeological Experimental Centre (HAF) in Denmark. One set of spools, each with a thickness of 4 cm and a weight of 105 g, here called small spools (fig. 2), and another set of spools, each with a thickness of 5.5 cm and a weight of 280 g, here called large spools (fig. 3), were reconstructed. Smaller spools have been found in the same context in Khania, but were not taken into consideration in this test. These may have been appropriate to use as supplementary weights or when weaving bands, as was demonstrated by Lise Ræder Knudsen. She used spools, typical of Italian Iron Age contexts weighing maximum 50 g as warp tension in tablet weaving, for making borders on a mantle (fig. 4) (Gleba Forthcoming; Ræder Knudsen 2002).

Find ID: KHA-71-TC 106
Material: Unfired clay
Estimated weight: 100 g
Thickness: 38 mm

Fig. 2. Reconstructed spool.
Weight: approximately 105 g
Thickness: approximately 4 cm

Find ID: KHA-71-TC 115
Material: Unfired clay
Estimated weight: 270 g
Thickness: 57 mm

Fig. 3. Reconstructed spool.
Weight: approximately 280 g
Thickness: approximately 5.5 cm

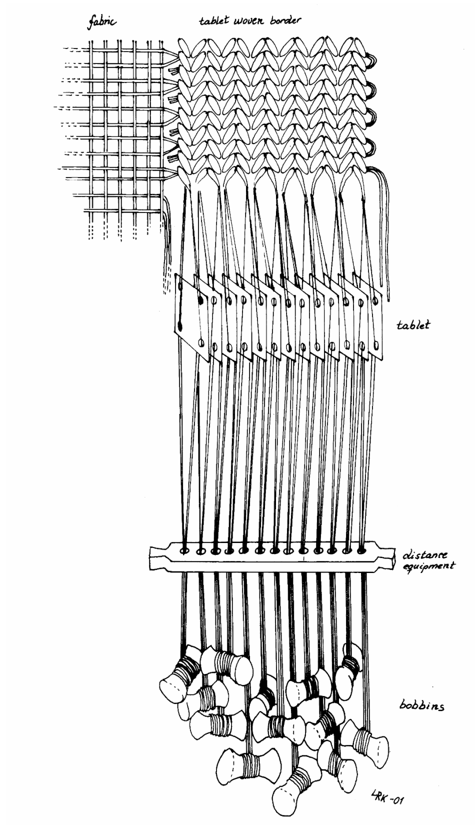


Fig. 4. Ræder Knudsen's use of small spools for making a tablet woven border. Each spool weighing maximum 50 g (Ræder Knudsen 2002:240).

In the present investigation, two questions were in focus:

- What loom setups are appropriate with the reconstructed spools as loom weights, e. g. what kind of yarn is suitable, how many threads per cm etc?
- How do spool shaped loom weights function in a warp weighted loom?

Guidelines

The weaving tests presented in the present report were designed as demonstrations of possible work processes and resulting fabrics. The guidelines of importance were:

- The primary parameter to be investigated is function
- Tools must be reconstructed as precise copies of archaeological artefacts
- All processes must be documented and described in writing, photographed and some filmed

The loom setups

The loom setups were arranged in order to fulfil the features in optimal weaving which were described in Part 3. We included the results of the tests in Part 3: that the total width the total width of loom weights should be the identical or slightly larger than the fabric to be produced, and still provide the thread tension required according to the yarn quality.

Features in optimal weaving:

- Loom in stable position
- Appropriate weight tension per thread
- Even distribution of weight per thread in the whole loom setup
- Loom weights positioned in the same level
- Loom weights positioned side by side
- Loom weights stable, i. e. not whirling or tangling
- Warp threads hanging vertically and evenly distributed
- Warp threads do not tangle
- Warp threads do not break
- Shed easy to change
- Weft is easy to insert evenly
- Identical width of fabric throughout the weaving
- Edges of the weave are straight
- Even and regular feeling when weaving

Two loom setups were made in a warp weighted loom which we got from HAF. One loom was set up with only small spools, and the other with only large spools. The setups were made as tabby weaves. Evidence of tabby weaving exists from Bronze Age Crete (Möller-Wiering 2006:4).[2] When weaving, a bone needle and a wooden sword beater were used as weft beaters (fig. 5, 6). The work with the two different setups will be described and treated separately in the following text.

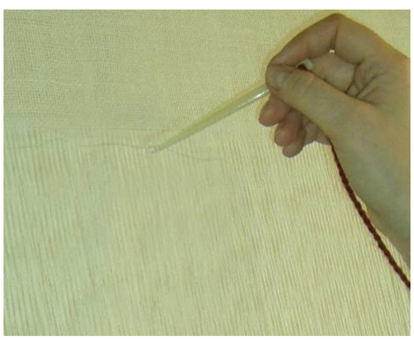


Fig. 5. Inserting the weft with a pin beater made of bone.

Fig. 6. Beating up the weft with a wooden sword beater.

[2] To our knowledge, the only preserved examples of twill are fragments from Alishar in Turkey dated to the late 4th millennium (Barber 1991:167, 168).

Small spools

Reconstructed spools

We had 24 reconstructed spools at our disposal. Each spool weighted approximately 105 g, in contrast to the original which had an estimated weight of 100 g. Since the spools were unfired, the weight fluctuated slightly depending on the humidity in the air. For example, the spools lost 2-4 g when they were moved from the storage in HAF to the weaving room at Copenhagen University. Our calculations were made based on a weight of 105 g and a thickness of 4 cm (fig. 2).

Yarn

In order to select a suitable yarn, we had to consider the thickness and weight of the spools. With two rows of loom weights for tabby weaving, the 24 spools had to be divided in to two layers of 12 spools in each. The total width of the spools positioned in a row was 48 cm. Taking into account the small weight of the spools, this meant that the spools would be suitable to produce an open fabric where the warp threads were distributed over about 48 cm with some space between them.

With an extremely thin yarn requiring about 10 g tension, the distribution would be about 5 warp threads per cm, thus giving a very open fabric. With a slightly thicker yarn requiring about 15 g tension, the distribution would be only about 3.5 warp threads per cm and thus result in an extremely open fabric. With a yet thicker yarn requiring about 25 g tension, these small spools would be suitable in a setup with only about 2 warp threads per cm. We decided to demonstrate the setup with the highest number of warp threads per cm, about 5 warp threads per cm, since the other possible setups would result in an extremely open fabric. We selected the thinnest machine spun wool yarn available requiring about 10 g tension (Yarn number 30/1, Z twist).[3] We estimated that such a yarn could have been spun using a spindle whorl weighing about 4 g, if very fine wool was used. This estimate was based on the results from the experimental research in Part 2:2 (Mårtensson *et al.* 2006b).

Fig. 7. Warping on a warping frame.

[3] We thank hand weaver Anna Nørgård for providing the yarn.

Warping

Warping was made with a rigid heddle and a warping frame (fig. 7). A 48 cm long warp faced starting border was made corresponding to the total width of the spools hanging in a row. In order to achieve a suitable tension per thread (10 g), 10 warp threads were attached to each spool. The starting border's weft threads, which constitutes the weave's 240 warp threads, were thus gathered in bunches of 10 threads in each. Every bunch of warp threads was attached to a spool during warping (fig. 8). The spools functioned perfectly for this purpose as long as they were resting on the floor and did not pull down the starting border with their weight (fig. 9). In this way, the thin and lively yarn could be treated in a very controlled and gentle way. Approximately 2 m warp threads were wound on each spool, and yet 3 m additional yarn would fit without bulging out and thereby being worn by the adjacent spools. This means that it would be possible to work with a 5 m long warp in this setup without having extra warp wound on separate implements tied to the loom weights or hanging freely.

Fig. 8. Attaching the warp threads to the spool by tying them with a loop around themselves.

Fig. 9. Spools resting on the floor during warping.

Loom setup and weaving

Since the warp threads were already tied to the spools with a loop around them (fig. 8), they could simply be pulled down and the length of the warp could easily be corrected if needed (fig. 10). The process of tying and arranging the loom weights on the warp threads was therefore not necessary. In this sense, setting up the warp on the loom was easier than if, for example, one used discoid loom weights, which need to be tied to the warp.

Three samples were woven. The first sample was the primary test and was therefore made as the largest sample. In order to demonstrate a more dense fabric, sample two was made using a thicker wool yarn as weft (100 g = ca. 1200 m). The yarn used as warp and weft in sample one was originally made with a hard spin in order to give a crepe effect to the fabric after washing. The aim of making a small third sample was therefore to demonstrate how sample one would react to washing.

Weaving was accomplished without any problems (fig. 11), and corresponded well to the features in optimal weaving outlined above. Initially, we assumed that the loom weights might tangle and twist the warp threads attached to them since they were spool shaped and did not have flat sides. This concern was not justified; the spools were hanging side by side in a row throughout the weaving (fig. 12). In conclusion, the spools functioned perfectly as loom weights in a warp weighted loom. Furthermore, there were no problems with the spools being unfired in their use as loom weights.

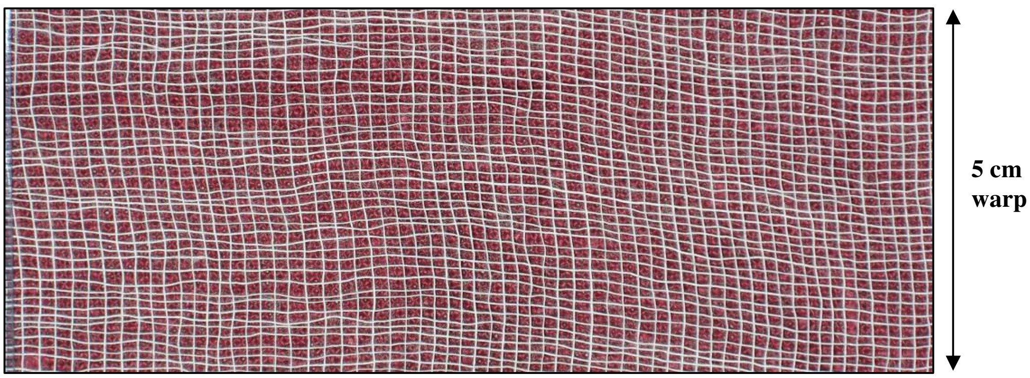
All woven samples are described with measurements in the following. The measurements were taken after the samples were cut down from the loom. Since the yarn was hard spun, the samples will probably shrink more after some time in a relaxed position in contrast to its position on the loom, tensioned by loom weights.

Fig. 10. Arranging the warp in the loom.

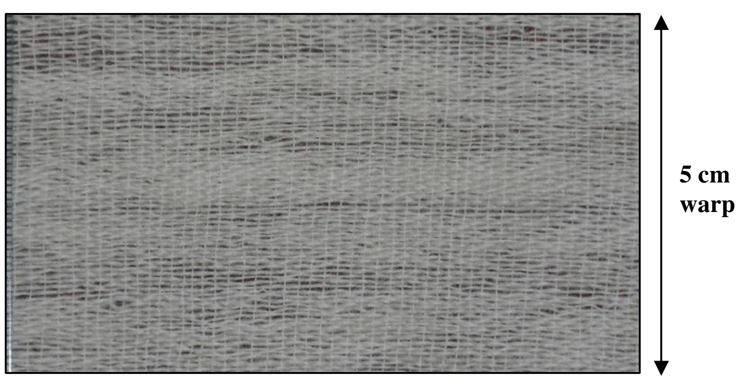
Fig. 11. Weaving in progress.

Fig. 12. Loom weights in two rows.

<u>Sample 1.</u> ca 48 (→) X 29 (↓) cm
Average: 5 warp threads per cm and 8 weft threads per cm, i.e. very open and weft dominated, giving a transparent impression. The hard spun yarn and the very open setup gave a lively and flexible appearance to the fabric.

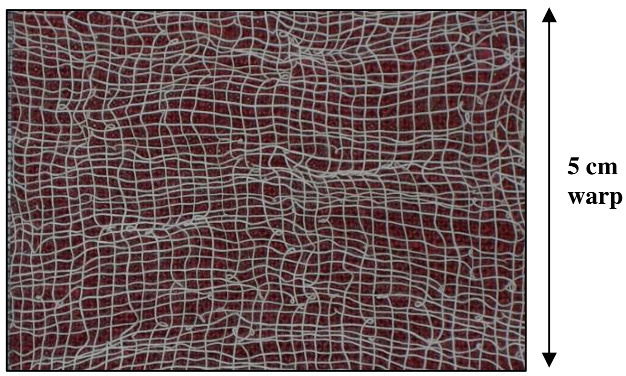


<u>Sample 2.</u> ca 46 (→) X 11 (↓) cm
Average: 5.8 warp threads per cm and 14.8 weft threads per cm, i.e. weft dominated.



Sample 3. ca 9 (→) X 7.5 (↓) cm
Average: 5 warp threads per cm and 8 weft threads per cm.
A small sample was made for the purpose of being washed and thus exemplifies how sample one would react to washing. After washing, the sample shrank a little. The threads curled in a three dimensional way, giving the piece a flexible and crepe appearance.

After washing: ca 8 (→) X 7 (↓) cm
Average: 5.4 warp threads per cm and 9.6 weft threads per cm.



Large spools

Reconstructed spools

We had 16 reconstructed spools at our disposal. Each spool weighed approximately 280 g, in contrast to the estimated weight of the original spool which was 270 g. Similar to the small spools, described in the above text, the weight of the spools fluctuated slightly. Calculations were made based on a weight of 280 g and a thickness of 5.5 cm (fig. 3).

Yarn

The spools in this setup had a larger weight and thickness than the small ones. Therefore, it was necessary to use a new yarn quality. With these heavier spools, it was appropriate to use thicker yarn. We had two rows with only 8 spools in each, in contrast to the earlier test with 12 spools in every row. Still the total width of the spools in a row was almost the same, 46 cm compared to the earlier test weaving measuring 48 cm. Since we wanted the starting border to be of identical width or slightly narrower than the row of loom weights, this meant that the warp threads needed to be distributed over a length of about 40-46 cm. The spools would, again, be suitable for an open warp setup.

If we had selected the same thin yarn as in the test described above, requiring 10 g tension, it would have been suitable to have about 10 warp threads per cm resulting in a quite open fabric. These thick spools, however, would gather the thin threads together in bunches, which most likely would have affected the structure of the fabric negatively. Instead, a thicker machine spun wool yarn was selected.[4] We estimated that such yarn could have been spun using a spindle with a whorl weighing about 8 g. This estimate was based on the results from the experimental research in Part 1 (Mårtensson *et al.* 2006). We estimated the yarn to require a tension of about 18 g per thread in the warp weighted loom, and consequently 16 threads were attached to each spool. With two rows of loom weights for tabby weaving, this meant 32 warp threads per 5.5 cm, and therefore only about 6 warp threads per cm thus resulting in an open fabric.

Warping

Warping was made in the same way as when using the small spools (fig. 7). A 41 cm long warp faced starting border was made which corresponded well to the slightly wider row of loom weights. In order to achieve suitable tension per thread (18 g), 16 warp threads were attached to each spool. The starting border's weft, which constitutes the weave's 256 warp threads, was thus gathered in bunches of 16 threads each. Every bunch of warp threads was attached to a spool during warping (fig. 6). Again, the spools functioned perfectly for storing the warp threads when warping. Approximately 2 m long warp threads were wound on each spool, yet 2 m additional thread would fit without having the threads bulge out too much. This means that it would be possible to work with, a total of, 4 m of warp in this setup.

[4] Perinnelanka (Nm 12/1) 100g = n. 1150m 100% wool, Z twist.

Fig. 13. Weaving in progress.

Loom setup and weaving

Just like in the previous test with small spools, the shape of the larger spools was also well suited for setting up in a warp weighted loom. The spools were hanging side by side in rows throughout the weaving (fig. 14, 15). Again, the spools functioned perfectly as loom weights.

One sample was woven. The weaving corresponded to the features of optimal weaving outlined in the beginning of this text, except for one point: the loom was not perfectly stable.[5] Except for this factor, weaving was done without any problems (fig. 13). The fabric was woven as an open tabby, but the setup would also be suitable for weaving a dense and weft faced tabby, as was the case with the smaller spools. The measurements of the sample taken after it was cut down from the loom follow.

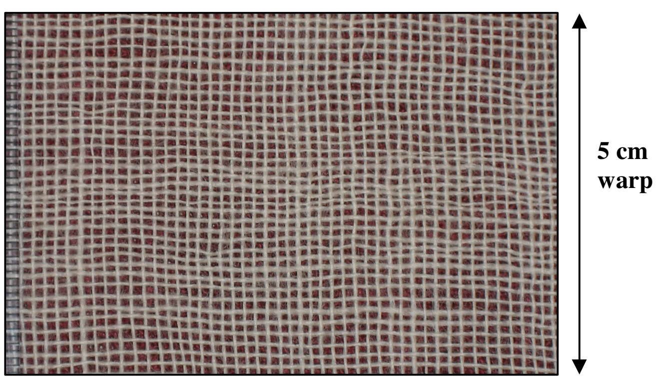
[5] The warp weighted loom used for weaving with the spools was made of uneven tree trunks and was thus rather rickety and the loom sometimes slid one or two cm to the side. While weaving, it was noted that the slightest movement of the loom affected the edges of the weave since the warp threads were displaced some millimetres. This problem was observed to a small extent while weaving with the small spools as well, but was not consequently noted down.

Fig. 14. Loom weights in two rows. Natural shed position.

Fig. 15. Loom weights in two rows. Counter shed position.

<u>Sample 1.</u> ca 41 (→) X 26 (↓) cm

Approximately 6.1 warp threads per cm and 7.4 weft threads per cm, i.e. open and rather balanced, giving a transparent impression.



Conclusion

In the present test, samples were woven in a warp weighted loom in order to illustrate what fabric can be produced and how it can be produced using two sets of reconstructed spools from Khania. Two questions were investigated: What loom setups are appropriate with the reconstructed spools as loom weights, and how do spool shaped loom weights function in a warp weighted loom? By conducting the tests, it was evident that the spools are very well suited as loom weights, not only in the process of weaving, but also during warping. The shape of spools is perfect for storing the warp threads and for keeping extra warp organised while weaving. Furthermore, there were no problems with the two different sets of spools being unfired in their use as loom weights. As to the question of what loom setups are appropriate, it was concluded that in the way we used the loom weights -hanging side by side in two rows- the weight and the thickness of the spools limited the type o fabric that could possibly be produced. Both a dense, weft faced sample and open, almost transparent samples were made.[6] The 4 cm thick spools weighing approximately 105 g were suitable to use with extremely thin wool yarn, requiring only about 10 g tension, in an open fabric with about 5 warp threads per cm. The larger spools, on the other hand, were suitable for thicker yarn requiring about 18 g tension, with about 6 warp threads per cm and resulting in an open fabric as well.

To conclude, the shape of the spools does have a practical function while weaving. It facilitates the work with setting up the warp on the loom. The weight and the thickness, however, are the most important factors which influence what kinds of textiles are suitable to be produced.

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[6] The latter samples form reminds to the so called veiled dancer of Thera.

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