A PRACTICE PROCEDURE FOR MAKING THE "TATAKI" CUBE: A LEARNING PROGRAM ON JAPANESE TRADITIONAL ARCHITECTURAL MATERIAL

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Keywords: traditional technique, teaching aid, clay, slaked lime, soil composition, compressive strength.

Introduction

Tataki is a traditional technique usually used in Japanese architecture, especially as a floor finish at the entrance (Fig. 1). It is made by kneading and then pounding a mixture of soil, slaked lime, bittern, and water [1]. The tools and materials to make *tataki* are quite simple. *Tataki* is an ancient practice that was established in Japan during the *Jomon* period, at least ten thousand years ago. Until cement and concrete became popular in the modern era, it was used for finishing the floors at entrances, as well as for mounding a building's foundation and preparing the ground. The occupants of a traditional farmhouse cooked meals, performed indoor agricultural activities, and bred cattle on a *tataki* floor as if it were outdoors. Therefore, it can be said that a *tataki* room has a unique atmosphere. Learning the techniques of *tataki* today may bring us further knowledge of traditional building materials, and inspiration to form new architectural spaces that have long been a part of Japanese culture.

Fig. 1 *Tataki* floor in a traditional house

This paper draws on the methodology proposed by Okuda et al. [2] for conducting a *tataki* workshop and investigates the proper soil composition (i.e., the ratios of clay and slaked lime) required to make *tataki* cubes. One of the features of the workshop is the use of paper boxes (e.g., Tetra Paks, generally used for storing wine, juice, and milk in Japan) for making *tataki* cubes 7 cm × 7 cm × 7 cm in volume.

Procedure for Making a *Tataki* Cube

This study uses a paper box identical to the one described by Okuda et al. [2] and develops a procedure for making a *tataki* cube. Since paper boxes are commonly available and easy to make at no additional cost, they could be used as a teaching aids in classrooms. The tools and materials (with quantities) required for the preparation of a *tataki* cube are shown in Table 1.

The procedure for making a *tataki* cube is as follows:

1) Pour 3/4 L of soil into a paper box that has a volume of 1 L. The box can be procured either by the workshop host or by a participant. The host is expected to organize the other tools and materials (see Table 1).

2) Pour the soil from the paper box into a transparent plastic bag. After cleaning the paper box, cut the box and draw measured lines on it as shown in Fig. 2. This makes it the inner form case of a *tataki* cube.

3) Install the inner paper form case inside the outer form case, which is constructed out of wooden boards, as shown in Fig. 3.

4) Add slaked lime and salt, as indicated in Table 1, into the plastic bag and mix with the soil. If the mixture is not damp, spray an adequate amount of water into the bag.

5) Pour the mixed soil into the form case until it comes up to the level of the lowest line marked. Then tamp the soil with the wooden bar, and flatten the surface.

6) Pour the mixed soil again, this time to the level of the next measured line, and tamp it until it is flattened. Repeat this operation twice, ensuring firm soil to a height of 7 cm from the bottom.

7) Extract the inner paper form case with the soil cube from the outer wooden form case by using the thick wooden plank.

Measuring the Compressive Strength of a *Tataki* Cube

Decomposed granite soil, also known as “ordinary soil,” contains a moderate ratio of clay to sand and is the best material for making *tataki*. Since the exact ratio of clay to sand is not known, *tataki* cubes were made using different ratios of materials as shown in Table 3, and compared for compressive strength. In this experiment, the decomposed granite soil used was the mix of coarse sand and mountain sand containing calcium chloride found on the

Table 1: Tools and materials for making a *tataki* cube

Tools for each group	Atomizer / Bucket / Wooden plank to force *tataki* cube out of form case (7 cm × 7 cm × 1-3 cm thick)
Tools for each participant	Measuring cup (500 mL) / Measuring teaspoon / Transplant shovel / Work mat / Transparent plastic bag (No smaller than A4 size) / Felt pen / Scissors / Ruler / Wooden bar for tamping (about 20 cm in length and thick enough to grip) / Paper form case (made from a paper box: see Fig. 2) / Wooden form case (see Fig. 3)
Materials for a *tataki* cube	Soil (3/4 L of loam soil, clay loam soil, or light clay: see Table 2) / Slaked lime (1/4 L) / Salt (teaspoonful, containing a small amount of bittern)

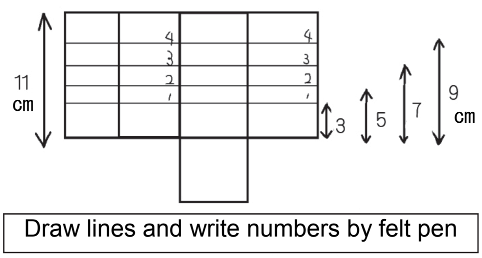

Fig. 2 Method of making an inner paper form case from a paper box

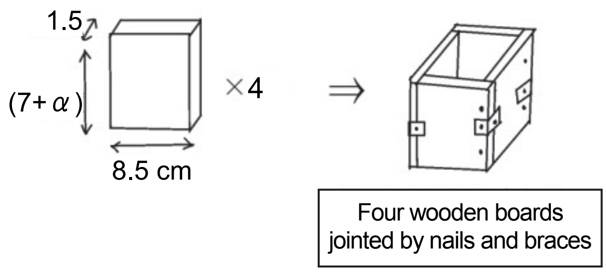

Fig. 3 Method of making an outer wooden form case

Table 2: Standard for judging a category of soil [3]

Category	Clay inclusion ratio	Properties
Sandy soil	< 5 %	Rough, not possible to form a solid figure with it.
Sandy loam soil	5 – 15 %	Feels like a mixture of sand with small amounts of clay. It can be formed into a thick bar.
Loam soil and clay loam soil	15 – 25 %	Feels like an equal mixture of sand and clay. It can be formed into a stick like a pencil.
Light clay	25 – 45%	Feels like a mixture of clay with small amounts of sand. It can be formed into a thin stick, like a matchstick.
Heavy clay	> 45 %	Feels slimy and sticky, it can be formed like a wick.

Table 3: Compressive strength of a *tataki* cube (average of two samples) [N/mm^2]

Combinations of soil types (c/s: ratio of clay to sand)	Ratio of soil to slaked lime			
	4:0	3:1	2:2	1:3
Decomposed granite soil	122	66.7	33.0	21.9
Clay	unable to measure.	17.5	10.2	11.0
Mixed soil #1 (c/s = 1:4)	—	44.2	—	—
Mixed soil #2 (c/s = 2:3)	—	10.2	—	—
Mixed soil #3 (c/s = 3:2)	—	18.5	—	—
Mixed soil #4 (c/s = 4:1)	—	18.0	—	—

playground of Miyagi University of Education. In addition, NN kaolin clay (Takehara kagaku kogyo Co., Ltd.), 70 slaked lime (Rimusaachi Ltd.), and *Asobi suna* [Sand for play] (Keiyo Co., Ltd.) were used as clay, slaked lime, and sand respectively. *Naruto no shio* [Salt of Naruto] (Naruto Salt Mfg. Co., Ltd.) including bittern was also added at a 5 % volume ratio to the soil for the *tataki* cube.

Results and Discussion of Experiment

Seven days after the cubes were made using the procedure described above, cracks over 4 cm in length appeared in the cubes that were made only of clay—especially the cube which did not have slaked lime, which was too brittle for the measurement of compressive strength. The compressive strength of *tataki* cubes was measured by applying downward pressure at a rate of 5 mm/min of movement, as shown in Fig. 4. Table 3 and Fig. 5 show the results and compare the compressive strengths of *tataki* cubes to C_2S and C_3S, which are the main components of Portland cement.

Fig. 4 Measurement of compressive strength of *tataki* cube

In general, *tataki* cubes made from decomposed granite soil rather than artificially mixed clay and sand had higher compressive strengths. Cubes with less slaked lime had higher compressive strengths. The highest compressive strength, which surpassed the value for

C_3S (46 N/mm^2), was observed when no slaked lime was added. This implies that decomposed granite soil is the appropriate material for making *tataki* cubes, and that the natural adulterant in soil assists in solidification. However, the compressive strength of the *tataki* cube made only of clay indicated 17.5 N/mm^2 at the highest. All mixed soil values were higher than the compressive strength of C_2S (5 N/mm^2) but there was no direct correlation between the ratio of sand to clay and the compressive strength values, probably because of the complications arising from chemical reactions, dynamic balance, etc. Although clear relationships do not exist between the soil mixture and compressive strength, each *tataki* cube investigated was as strong as expected.

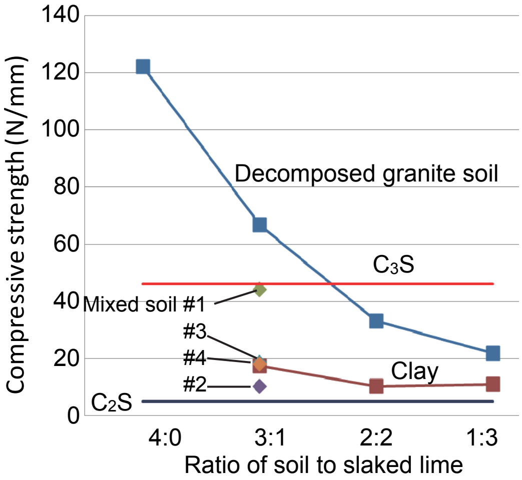

Fig. 5 Comparison of compressive strengths of *tataki* cubes and cements at the material age of seven days

Conclusion

The goal of this study was to develop a learning program for understanding *tataki* by setting down practice guidelines, and defining a procedure for making *tataki* cubes. Cubes were made as part of this study, and their compressive strength characteristics were investigated. The workshop takes no more than 2 h to facilitate, making it ideal for University classes. University students enjoyed the program when it was offered, and have given it favorable feedback. The next step is to understand the effects of moisture regulation on *tataki*, and continue the investigation into *tataki* cubes.

Acknowledgement

I wish to express my gratitude to Prof. Masato Kawamukai, Mr. Sho Okuda, and Ms. Yuriko Otomo for their helpful suggestions and assistance. This work was supported by JSPS KAKENHI Grant Number 26560031.

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