*Advances in Social Science, Education and Humanities Research (ASSEHR), volume 227*
1st International Conference on Advanced Multidisciplinary Research (ICAMR 2018)

# Measuring the Shrinkage Properties Power of Local Soil Material to Produce the Accuracy of the Shape and Size of the Art Crafts Ceramic

Ali Ahmad Muhdy
*Art and Design Faculty*
*Universitas Negeri Makassar*
Makassar, Indonesia
aliahmadmuhdy@gmail.com

Irfan
*Art and Design Faculty*
*Universitas Negeri Makassar*
Makassar, Indonesia

Solihing
*Art and Design Faculty*
*Universitas Negeri Makassar*
Makassar, Indonesia

***Abstract*—The shrinkage of clay as a ceramic material is the process of changing size and weight when the water content decreases and evaporates due to drying and burning. In general, pottery craftsmen in Takalar Regency do not understand misunderstand and have not been able to be measure the shrinkage of soil material so that the results of the pottery made are always different in size and weight between the shapes of one with the others. This research was carried out in Sandi Takalar Regency with the aims of explaining a simple way of measuring the soil shrinkage properties power and predicting the shape and size of ceramic craft art made by craftsmen. Qualitative research methods were conducted with data collection techniques in the form of observation, experimentation, and recording. The sampling technique was purposive by testing local clay combinations that were considered good and existed in South Sulawesi. The results showed that all local soil experienced an average shrinkage of 1.6 cm x 0.9 cm, occurring during drying and burning. Depreciation of the average weight is 0.31 cm. Depreciation of weight during drying an average of 0.21 kg and with average combustion of 0.1 kg. The most shrinkage occurs when drying indoors and outdoors, therefore, to determine the accuracy of the desired ceramic art form, the craftsman must overestimate enlarge the wet size is about 1.6 cm x 0.9 cm from the expected shape, and exaggerates rearrange the wet weight of 0.31 kg from the weight expected to produce shape, weight, and size according to the expectations demands of the consumers and stakeholders.**

***Keywords—shrinkage, measuring, shape accuracy, ceramics***

## I. INTRODUCTION

Ceramic art is produced from clay which is processed with various techniques, both manually and machine. In general, the centers of ceramic arts spreading in every various region in Indonesia, and they are still closely related with to the agrarian culture with traditional manual processing techniques, including in Sandi, Takalar Regency. In Takalar, it is not yet known when ceramics were made, but the making of ceramics is believed to have lasted a long time and is still ongoing. Pottery making is a tradition that has been passed down from generation to generation [1]. One of the weaknesses of the ceramic arts in Takalar is the quality of raw materials that have not been treated properly, relying more on manual processing techniques with earthenware type soil material for pottery art products [2]. As part of small and medium Enterprises, small ceramic business groups cannot be separated from general problems such as: lack of capital, marketing difficulties, simple organizational structure with non-standard division of labour, low management quality, limited human resources, low product quality, most have no financial reports, weak legal aspects, and low technology quality [3]. From the aspect of the local ceramic material in Takalar, the results of the raw material body characterization with clay masses which are mashed through the milling process with pot mills and mixers show an increase in physical properties that are relatively better than the raw body with clay mass processed without going through the process grinding / refining first [4]. One of the main weaknesses of the art of ceramic crafts is the low quality of the product because the raw materials used have not been processed properly, so it requires alternative efforts to develop the art of ceramic crafts. Regarding the problem of raw materials, processing techniques are still manual, the type of soil used is less varied, and has not done the soil well and has not been able to shrink the shrinkage of the materials used.

The soil used as a material for making ceramics in Takalar is a type of earthenware soil, low burn type. In general, Hector divided types of soil for ceramic by three types [5] divides three types of soil for ceramics, 1) Earthenware soil (900 ° -1100 °), is a type of low burnt soil. The burning color that is caused is red, pink, or brown. 2) The soil of Stoneware (1150 ° -1250 °), is a type of high burnt soil, the burn color caused by gray. 3) Porcelain Soil (1260 ° -1350 °), this soil is its own blend. Cannot be obtained from natural sources directly as in the above soil types. The color of the fuel that it causes is white. The type of soil that is widely used by earthenware craftsmen in Takalar is Earthenware soil type with a fuel temperature (900 ° -1100 °).

Regarding the low quality of the product, in general almost happened to all many ceramic handicraft products, so did the art of ceramic crafts in Takalar. In the aspect of form is still lacking in specific precision, due to the size that has not been standardized, each ceramic craft art made in the same shape and size will eventually have a different shape and size difference. This is because ceramic products experience shrinkage during drying and combustion, the shrinkage will absolutely reduce the size and shape made, although shrinkage does not cause a significant difference, but can reduce the quality value of the art form of ceramic crafts. Therefore, efforts to measure the shape and estimate the shrinkage that will occur in ceramics can help the

Copyright © 2019, the Authors. Published by Atlantis Press.
This is an open access article under the CC BY-NC license (http://creativecommons.org/licenses/by-nc/4.0/).

craftsmen in reducing the occurrence of errors in the expected shape and size. The test method used is a simple measurement by measuring the weight and size of the form when wet, dry, and after being burned, the measurement results are then analyzed descriptively qualitatively using interpretation.

## II. METHODS

Qualitative research methods were used and data collection techniques in the form of observation, experimentation, and recording. The sampling technique was purposive by testing 4 local clay and their combinations that were considered good around South Sulawesi.

## III. .RESULT

Before discussing simple ways to measure soil shrinkage, we first understand the properties of soil as raw material. Some natural properties of the soil are:

- Color, colorless (white) pure soil (kaolinite), the color depends on the ingredients (pelicans) mixed in the soil, the color can be black, red, brown or other. In South Sulawesi this type of soil can be found in the Jeneponto district; Gray to black soil is caused by having a charcoal content (residual from plants) that are evenly distributed. Generally found in Takalar and Gowa districts. This type of clay is always used by pottery craftsmen in Takalar district and Gowa regency including in the Jipang Village to produce ceramics. Red soil, generally because the soil contains iron oxide (Hematite, $Fe_2O_3$) which is evenly distributed. There are many in various regions such as Toraja, Maros, Barru, Pangkep, Gowa, and Sinjai. But the proven good quality is soil from Pangkep and Toraja. Yellow soil: cream or slightly brown. Contains limonite ($2\ Fe_2O_3.3H_2O$). Depending on the level of limonite which is evenly divided. This type of soil is widely found in Toraja. Green soil, containing iron-based silica pelicans. If this amount is rather large and evenly divided, the color will be greenish.
- Structure, the soil structure in question is a comparison of the size of the soil grains and the shape of the granules. The properties of clay, dry shrinkage, and dry strength are largely determined by the structure of the soil. Some of the soil particles can be seen with the eyes, and some cannot be seen because they look very fine. So there is a fine soil structure consisting of very fine soil substances and rough structures like sand. To find out the ratio of the large grains of the soil in the processing process is usually used a variety of filter devices, each with a large hole. The smallest filter is the hole with 10,000 wires per cm2.
- Dry Shrink; As explained above, the nature of clay is the nature of wet soil that can be processed and given shape. Then on dry soil, it is necessary to add enough water to be formed (forming water). In accordance with its state in the soil, the forming water has 3 types: a) Membrane water, water which is a thin membrane covering the soil grains to allow the shifting of the grains; b) Water sucked by colloid fractions; c) Pore water, the water that enters the pits between the grains. If wet soil is drained, the membrane and colloidal water will evaporate, and the grains will become tight and cause shrinkage (dry shrinkage). But the water that is still in the small holes (pores) between the grains, if then evaporates will not cause shrinkage again. Very plastic soil requires more water than ordinary clay. Therefore dry dryness will be higher. So the amount of water added is very much related to the shrinkage of the soil. To reduce shrinkage from the soil, it must be added with non-plastic materials such as sand.

The type and origin of the soil tested is the shrinkage:

- Soil from Soreang, and from Jipang Village, at Bontonompo District, in Gowa Regency. The soil of Soreang in question has been used by a craftsman to make fine ceramics, the soil is combined with fine husk ash as a sand replacement binder, the result is quite good at a maximum burn of 700 with a field stove, this soil will be tested as one sample and given a Soreang soil 1;
- The original soil of Takalar obtained in Sandi, Pallantikan, Pattallassang Subdistrict, Takalar Regency, for decades, this type of soil has been used by local craftsmen to make pottery and chairs and jars, generally this type of soil is mixed with sand with a ratio of 70% of soil and 30 % sand, then this soil is called Sandi soil 1.
- The original soil from Soreang without a mixture of husk ash, but replaced with a mixture of Silica, Talk, and Kaolin. The comparison is 80 soil and 20 (silica, talk, and kaolin), then this type of soil will Soreang soil 2.
- Soil from Pangkep district is usually obtained from the Tonasa 2 area (Semen Tonasa Plant Area) most commonly used as a practical material for students of UNM FSD Fine Arts Education and Ceramics students at Sombaopu State Vocational High School 2 Gowa Regency. This soil will be used 100% without using any mixture and is referred Pangkep soil 1.
- The soil mixed from Pangkep soil and dry soil with a comparative weight of 50 Pangkep and 50 Soreang, will then be referred Pangkep soil 2.
- Soil from Pangkep 80% mixed with Silica, Talk and Kaolin (STK), 20%, hereinafter referred Pangkep soil 3.
- Soil Soreang mixed with STK with a ratio of 85% of Soreang Soil and 15% of STK, hereinafter referred Soreang soil 3.
- Soreang soil + Pangkep 85% mixed with 15% STK material Then called Sorpang soil.
- Pangkep Soil 85% plus 15% STK material hereinafter referred to as Pangkep soil 4.
- Soil from 90% password added with 10% rubbing ash, is used by craftsmen Yunus Daeng Siama to make jars, chairs, and various other ceramic products, hereinafter referred to as Sandi soil 2.
- Takalar's original soil is filtered with 60-100 mesh sieves as much as 85% mixed with 15% STK material, hereinafter referred to as Sandi soil 3.

- Limbung soil as a material for making red stones (bricks) by residents around Limbung is referred Limbung soil.
- The original Soreang soil mixed with husk ash is called Soreang soil 4 (Daeng Sija processing)
- Pottery that has been baked by biscuits Dg Sija is called Soreang soil 5 (glaze in the Lab)

The results of testing the shrinkage measurements of the 14 types of local clay will be described in two tables. Table 1 describes the shrinkage of height and width directly dry and burnt, while Table 2 describes the weight loss by leaving dry shrinkage and fuel loss.

TABLE I. HEIGHT AND WIDTH SIZE SHAPES

| Types of products | Wet size (cm) | Dry size (cm) | Burn size (cm) | High shrinkage | Wide shrinkage |
|---|---|---|---|---|---|
| Flower Vase | 18 – 9 | 16 – 8 | 16 – 7.8 | 2 | 1.2 |
| Ewer | 20 – 10 | 18 – 8.5 | 18 – 8.5 | 2 | 1.5 |
| Vase | 17 – 10 | 16 – 8.5 | 16 – 8.5 | 1 | 1.5 |
| Ewer | 10 – 10 | 10 – 9 | 9.5 – 9 | 0.5 | 1 |
| Vase | 20 – 10 | 18 – 9 | 18 – 9 | 2 | 1 |
| Ewer | 19 – 10 | 16.5 – 9 | 16.5 – 9 | 2.5 | 1 |
| Vase | 19 – 9 | 16 – 7.5 | failed | | |
| Ewer | 21 – 9 | 18 – 8 | failed | | |
| Small ewer | 14 – 9 | 12 – 8.5 | 12 – 8.5 | 2 | 0.5 |
| Big ewer | 16.5 – 11 | 14 – 9 | 13.5 – 9 | 3 | 1 |
| Vase | 15 – 9 | 12.5 – 8 | failed | | |
| Ashtray | 6 – 13 | 5 – 11.5 | failed | | |
| Ashtray | 7 – 12 | 5 – 11 | 5 – 11 | 2 | 1 |
| Ewer | 19 – 10 | 18 – 8.5 | 18 – 8.5 | 1 | 1.5 |
| Ewer | 18 – 8 | 17 – 7.5 | 16 – 7.5 | 3 | 1 |
| Vase | 22 – 11 | 19.5 – 9.5 | failed | | |
| Ewer | 19 – 10 | 17.5 – 8.5 | failed | | |
| Ewer | 12 – 9,5 | 11 – 9 | 11 – 9 | 1 | 0.5 |
| Big ewer | 14 – 11 | 13.5 - 11 | 13 – 10.5 | 1 | 0.5 |
| Small ewer | 14 – 9 | 13 – 9 | 13 – 9 | 1 | 0 |
| Big ewer | | | | | |
| Big ewer | | | | | |
| Soreang vase | 12 – 10 | 11 – 9.5 | 11 – 9.5 | 1 | 0.5 |
| | | | | 25:15=1.6 | 13.7:15=0.9 |

In table 1 No. 1 (Soreang soil 1) it is seen that it has a wet height of 18 cm, a wet width of 9 cm, and a dry height of 16 cm. The size of the dry width after being burned is 8 cm, after being burned the width is reduced by 0.2 cm, so the width is reduced to 1.2 cm. Thus, the afternoon soil 1 has a high shrinkage of 2 cm and a shrinkage width of 1.2 cm. Specifically, in Soreang soil 1, it has a shrinkage of 2 cm in height and 1.2 cm in width. Thus for Soreang 1 soil type, if the expected normal shape size is 20 cm x 10 cm, then the wet size prepared is 22 cm x 11.2 cm, anticipating shrinkage height of 2 cm and width of 1.2 cm.

In general, in table 1 it can be seen that the average shrinkage size of the height is 1.6 cm, while the shrinkage width is 0.9 cm. Width shrinkage is less than altitude shrinkage. The dry shrinkage is a result of the shrinkage that has been combined between drying and burning. Through the results of the calculation of high shrinkage and width shrinkage, it can be predicted the shrinkage of local ceramic material with a high shrinkage of about 1.6 cm and a width of 0.9 cm. Therefore, if you want to make a vase with a height of about 15 cm and a width of 8 cm, the size of the wet shape that must be made is around 16.6 cm high and 8.9 cm wide, so that it can achieve shape height precision according to the planned size 15 cm and 8 cm wide.

TABLE II. DRY AND BURN SHRINK

| Types of soils | Types of products | Gross weight (kg) | Dry weight (kg) | Dry shrinkage | Burn weight (kg) | Burn shrinkage |
|---|---|---|---|---|---|---|
| Soreang Soil 1 | Flower Vase | 0.5 | 0.3 | 0.2 | 0.3 | 0 |
| | Ewer | 1 | 0.8 | 0.2 | 0.6 | 0.2 |
| Sandi Soil 1 | Vase | 1 | 0.9 | 0.1 | 0.8 | 0.1 |
| | Ewer | 0.7 | 0.5 | 0.2 | 0.5 | 0 |
| Soreang Soil 2 | Vase | 0.6 | 0.5 | 0.1 | 0.5 | 0 |
| | Ewer | 1 | 0.8 | 0.2 | 0.8 | 0 |
| Pangkep Soil 1 | Vase | 0.5 | 0.4 | 0.1 | | |
| | Ewer | 0.8 | 0.6 | 0.2 | | |
| Pangkep Soil 2 | Small Ewer | 0.8 | 0.5 | 0.3 | 0.4 | 0.2 |
| | Big Ewer | 0.8 | 0.6 | 0.2 | 0.5 | 0.1 |
| Pangkep Soil 3 | Vase | 0.4 | 0.3 | 0.1 | | |
| | Ashtray | 0.6 | 0.5 | 0.1 | | |
| Soreang Soil 3 | Ashtray | 0.7 | 0.6 | 0.1 | 0.6 | 0 |
| | Ewer | 2 | 1.4 | 0.6 | 1.3 | 0.1 |
| Sorpang Soil | Ewer | 1.5 | 1.1 | 0.4 | 0.7 | 0.4 |
| Pangkep Soil 4 | Vase | 1.3 | 1 | 0.2 | | |
| | Ewer | 1.5 | 1 | 0.2 | | |
| Sandi Soil 2 | Ewer | 1.3 | 1 | 0.3 | 0.9 | 0.1 |
| Sandi Soil 3 | Big Ewer | 1.5 | 1.2 | 0.3 | 1.1 | 0.1 |
| | Small Ewer | 1 | 0.9 | 0.1 | 0.8 | 0.1 |
| Limbung Soil | Small Ewer | 1 | 0.8 | 0.2 | 0.7 | 0.1 |
| | Big Ewer | 1 | 0.8 | 0.2 | 0.7 | 0.1 |
| Soreang Soil 4 | Vase | 1 | 0.8 | 0.2 | 0.7 | 0.1 |
| Soreang Soil 5 | Vase And Ewer | 1.2 | 0.9 | 0.3 | 0.8 | 0.1 |
| Everage | | 1.17 | 0.75 | 0.21 | 0.70 | 0.1 |

The results of the measurement of the weight loss on soil material Sandi soil 1 type of flower vase product (item no. 2 in table 2) shows that the wet weight is 1 kg, after drying the question decreases to 0.9 kg so that it shrinks 0.1 kg, after burning, the weight reduced to 0.8 kg, shrinking 0.1 kg. The total dry and burn shrinkage in the sandy soil 1 soil is 0.2 kg. Thus, specifically for the type of Soil 1 soil, if the expected normal weight of the ceramic is 12 kg, then the wet weight that must be prepared is 12.2 kg. Prediction of shrinkage is 0.2 kg, so the normal product will return to 12 kg.

The test results of dry and burn shrinkage on weight in Table 4 shows that the average wet weight of the ceramic tested is 1.17 kg, after drying the average weight decreases to 0.75 kg, experiencing a reduction of about 0.42 kg , with an average dry shrinkage of 0.21 kg. The weight after being burned is an average of 0.70, experiencing a reduction of 0.5 kg with an average burn weight of 0.1 kg. So the average dry fuel shrinkage is 0.21, and the average fuel loss is only 0.1 kg. This shows that the drying shrinkage is higher than the burn shrinkage. In total the average dry and burn weight loss is 0.31 kg. Thus, if the expected weight of finished ceramics is 1 kg, the wet weight of the soil used is 1.31 kg. 0.31 kg is prepared to anticipate dry and burning shrinkage.

After describing the shrinkage size and weight of local soil material in Takalar Regency and its surroundings, it can be seen that in each type of soil can have a different shrinkage both in terms of shrinkage and weight loss. By looking at the average shrinkage size as shown in Table 1, the average height is 1.6 cm, while the shrinkage width is 0.9 cm. Width shrinkage is less than altitude shrinkage. While the weight loss in table 2 in total dry weight and burn weight is 0.31 kg on average. Thus, if the ceramic form is planned and expected the final size is 15 cm x 10 cm with a weight of 1 kg, then the wet size that needs to be made is 16.6 cm x

10.9 cm and weighs 1.31 kg. For larger sizes, it is likely to experience greater shrinkage, because in addition to more soil material, more weight and moisture content.

## IV. CONCLUSION

There were 14 local soil samples tested for their shrinkage, but 3 of them failed at the time of combustion (Pangkep 1 soil, Pangkep 2 soil, and Pangkep soil 3). The plasticity of the three soil materials was good but poorly burned in stoves using firewood. Therefore, the three types of soil were not included in the next test. Furthermore, the 11 types of local clay tested and measured for their shrinkage have varying size and weight shrinkage, but the difference is not significant. Therefore, the average shrinkage size and weight loss are made.

The average shrinkage size as in Table 1, the average height is 1.6 cm, while the shrinkage width is 0.9 cm. Width shrinkage is less than altitude shrinkage. While the weight loss in table 2 in total dry weight and burn weight is 0.31 kg on average. Thus, if the ceramic form is planned and expected the final size is 15 cm x 10 cm with a weight of 1 kg, then the wet size that needs to be made is 16.6 cm x 10.9 cm and weighs 1.31 kg. More simply, small and medium-sized ceramics to be made must be exceeded by 1.6 cm in height, and 0.9 in width, while the weight must be exceeded by 0.31 kg.

## REFERENCES

[1] M. Kulkova, A. Mazurkevich, and E. Dolbunova, "Paste recipes and raw material sources for pottery-making in hunter-gatherer communities in the forest zone of Eastern Europe (Dnepr-Dvina region, 7–6th millennia BC)," *J. Archaeol. Sci. Reports*, vol. 21, pp. 962–972, 2018.

[2] A. A. Muhdy, J. Jalil, and I. Irfan, "Pemanfaatan Bahan Baku Lokal untuk di Glasir Guna Meningkatkan kualitas Gerabah (Earthenware) Menjadi Keramik Di Dusun Sandi Kecamatan Pattallassang Kabupaten Takalar," in *Prosiding Seminar Nasional" Membangun Indonesia Melalui Hasil Riset"*, 2017, pp. 169–174.

[3] W. J. V. de Souza, G. Scur, and W. de Castro Hilsdorf, "ECO-INNOVATION PRACTICES IN THE BRAZILIAN CERAMIC TILE INDUSTRY: The case of the Santa Gertrudes and Criciúma clusters," *J. Clean. Prod.*, 2018.

[4] J. Geng and Q. Sun, "Effects of high temperature treatment on physical-thermal properties of clay," *Thermochim. Acta*, vol. 666, pp. 148–155, 2018.

[5] H. V. Cabadas-Báez *et al.*, "Soils as a source of raw materials for ancient ceramic production in the Maya region of Mexico: Micromorphological insight.," *Boletín la Soc. Geológica Mex.*, vol. 70, no. 1, 2018.