QUICK MEASUREMENT OF MOISTURE CONTENT OF SOIL

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INTRODUCTION

Measurement of soil moisture with an ordinary thermostatic oven takes rather long time, and is not convenient for most purposes, e.g., for earthwork control.

In this country, natural moisture content of soil is very high because of climatic conditions, and also probably because of its volcanic origin. Therefore, the fact that moisture of the soil is much higher than its optimum under compaction always causes engineers much trouble.

A handy equipment has for a long time been waited for to dry the soil in the field before it is spread and compacted. One of the writers had for some years experimented in drying soil by heating and by exposing it in hot air, until it seemed to him that these were not very convenient for their purpose, and therefore, he had to find out some other ways.

This paper presents the results of experiments in drying soil by high frequency current oven with hot air blast. Samples were of small size, but were of such kind that it seemed rather difficult to dry them completely. The results were quite satisfactory, and the time required to drive out 98 to 99 per cent of the soil moisture was less than 20 minutes.

It is shown that this principle is well suited for quick measurement of moisture content, and it awakens hopes for possibility of developing a similar equipment of larger scale.

APPARATUS

The high frequency current oven is not specially designed for this purpose but of a common type which can be found in the market (Fig. 1). An electric current is led into the oven through a feeder and a matching box. The oven has a chimney which is equipped with an electric heater at the bottom. With this heater hot air is supplied into the oven and flows through the space between soil samples. This part of the oven was designed by Hasegawa of the Ministry of Transportation.

Soil samples are placed between electrodes of circular perforated discs as shown in Fig. 2. With such devices, samples are exposed to the flow of hot air and heated by high frequency electric current.

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Fig. 1. High-frequency Oven

High-frequency Oven

SAMPLES

Tests were performed on four kinds of soil. Two were loam (volcanic clay Kanto loam) and other two were clays. Their physical properties are shown in Table 1, and also in Figs. 3 and 4.
Water is added to soil, molded and consolidated into a form of a disc.

EXPERIMENTS

Soil samples were placed between electrodes and dried under various conditions tabulated in Table 2.

### Table 2. Conditions of Experiments

<table>
<thead>
<tr>
<th>Soil Type</th>
<th>Soil Source</th>
<th>Classification</th>
<th>Specific Gravity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kanto-Loam (1)</td>
<td>Hongo, Tokyo</td>
<td>Clay loam</td>
<td>2.813</td>
</tr>
<tr>
<td>Kanto-loam (2)</td>
<td>Hongo, Tokyo</td>
<td>Silty loam</td>
<td>2.785</td>
</tr>
<tr>
<td>Clay (1)</td>
<td>Otemachi, Tokyo</td>
<td>Clay</td>
<td>2.731</td>
</tr>
<tr>
<td>Clay (2)</td>
<td>Otemachi, Tokyo</td>
<td>Clay</td>
<td>2.694</td>
</tr>
</tbody>
</table>

i) Drying:
   a) by high frequency current and b) putting in heated air.
   c) flowing hot air.
b) by high frequency current.
c) by putting in heated air.
d) with an ordinary thermostatic oven.

ii) Size of sample:
   a) diameter: 50 mm.
   b) thickness: 10 mm., 5 mm., and 3 mm.; 5 mm. for samples formed by consolidation and then broken into 16 equal sectors.

iii) Plate on which sample is placed:
   a) water glass.
   b) copper plate with the edge of 2 mm. high.
   c) copper plate with no edge.

iv) Distance between electrodes:
   25 mm., 20 mm., 10 mm., and 7 to 8 mm.*

v) Number of samples for each experiment: 3.

vi) Time interval of observation: 10 min., 20 min.*, 30 min., 60 min., 90 min., and 120 min.

vii) Oven temperature:
    Adjusted to 110°C at the start of experiment. In case of experiment with high frequency current only, starts with room temperature.

viii) Soaking:
    Some of the samples were soaked in alcohol prior to experiments. Items marked (*) were used.

The degree for drying was calculated by Equation (1) in per cent as compared with that of the sample dried for 24 hours in an ordinary thermostatic oven.

\[ D_d = \frac{W}{W_{24}} \times 100(\%) \]  

where \( D_d \): The degree for drying, \( W \): the water content obtained from new method, \( W_{24} \): Water content obtained from 24-hr. drying by ordinary method.

![Graph showing drying degree over time](image)

**Fig. 5. Kanto Loams (1) and (2)**

Sample........ Diameter: 50 mm., thickness: 3 mm., soaked in alcohol, formed by consolidation.
Plate............ Non-bordered copper, diameter: 65 mm., thickness: 1 mm.
Electrode interval........... 7 to 8 mm.
Fig. 6. Clays (1) and (2)

Sample........ diameter: 50 mm., thickness: 3 mm.,
soaked in alcohol, formed by consolidation.
Plate........... non-bordered copper, diameter: 65 mm.,
 thickness: 1 mm.
Electrode interval........... 7 to 8 mm.

RESULTS

Two types of drying characteristics appear in Figs. 5 and 6, showing that the samples were dried up to 98 to 99 per cent in less than twenty minutes.

From the tests under various conditions the following conclusions were drawn:

i) The smaller the distance between electrodes and hence the smaller the thickness of sample, the greater is the efficiency of drying.

ii) For broken samples the efficiency is higher.

iii) Soaking in alcohol increases efficiency.

iv) It is more efficient to place a sample on a copper plate than on a watch glass.

v) When only high frequency current is applied, efficiency of the oven is not higher than that of an ordinary thermostatic oven. The highest efficiency can be achieved when high frequency current is combined with flowing hot air.

ACKNOWLEDGEMENTS

The writers deeply appreciate the financial support given by the Ministry of Construction, and the valuable suggestions and advices given by the members of the Soil and Foundation Committee of the Construction Mechanization Association of Japan are also acknowledged.