

Measurement of Moisture Content and Volume Change Distribution Inside Cement Paste Specimens Using X-Ray CT Imaging

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1 Introduction

In a dry condition, moisture escapes from the concrete specimen, resulting in a change of the volume inside the concrete. The volume change is distributed inside the specimen because the concrete is a mixture of several materials with different properties. However, the volume change of each material and the interaction between the materials has not been clarified sufficiently.

If the three-dimensional volume change and moisture content distribution inside the specimen can be quantified, the interaction between the volume changes of each material would be able to be understood more in detail.

We focused on X-ray CT. X-ray CT images show a three-dimensional distribution of X-ray absorption. When the moisture content in the paste changes, the apparent density in the paste changes. Therefore, the degree of X-ray absorption may change. On the other hand, the deformation inside the specimen before and after drying can be measured by 3D image correlation method. If these results are integrated, it is considered that the volume change due to the local water content change inside the specimen will be clarified.

In this study, we measured the relative absorption intensity obtained from X-ray CT images before and after placing a paste sample with a diameter of 75 mm in a dry condition and the volume change obtained by the image correlation method.

2 Experimental Results and Discussion

Shrinkage strain of paste increased linearly until the drying period of 35 days. It became about 6000×10^{-6} at 134 days of the drying period and almost converged. On the other hand, the length change in the case of crushed stone and crushed brick was smaller than that of the paste because of a reduction of paste volume due to containing the particles.

Figure 1 shows the intensity rate based on intensity difference between saturation and equilibrium in case of the paste. At early days, the intensity rate decreased near the surface. After that, shape of moisture distribution does not almost change and it was approximately same reduction value in all depth. Intensity reduction means change of the bulk density of paste. On

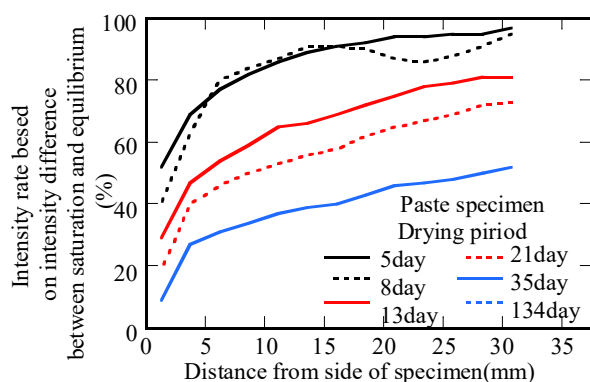


Figure 1. Intensity rate based on intensity difference between saturation and equilibrium.

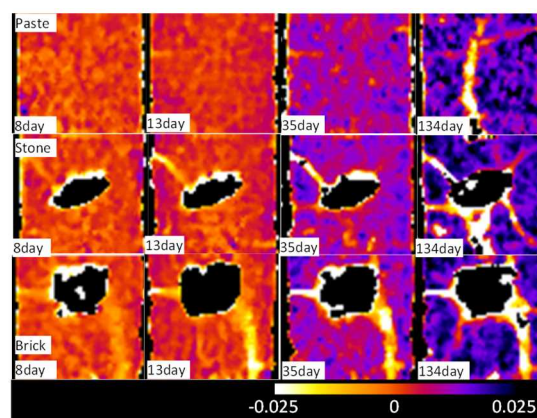


Figure 2. Volumetric strain distribution inside the specimen based on DVC measurement.

the other word, this rate means a change of moisture situation.

Figure 2 show the volumetric strain distribution inside each specimen based on DVC. In the paste case, volumetric strain was no change until the drying period of 8 days, however decreased from the side at above 13 days. After that, the shrinkage strain widened on the whole. Large expansion strains indicate cracks.

In the case of crushed stone and crushed brick, the inside volumetric strain started to decrease as in the case of paste. However, at 35 days of drying period, the shrinkage strain around the particles appears to be smaller than the other parts. Several areas of small expansion strain were observed from 8 days of the drying period. Finally, some cracks occurred from the surface of particle to that point and the width increased. The reason being the surface of particle has adhesive strength to the paste.

In addition, the paste specimen's results of Figures 1 and 2 shows that a noticeable shrinkage strain occurred above 50 % of the difference of moisture content between saturation and equilibrium.

3 Summary

The results of this study showed the results using intensities inside the image and image measurement indicated the water content and the volume change. In the future, the volume change due to the local water content change inside the specimen will be able to be clarified.

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