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論文審査の要旨

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| 博士の専攻分野の名称 | 博　士　（　工学　） | 氏名 | ADHITYA LEONARD WIJAYA |
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論　文　題　目

A comprehensive study on the mechanical and durability properties of expansive concrete

（膨張コンクリートの力学特性と耐久性に関する包括的研究）

論文審査担当者

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〔論文審査の要旨〕

In this dissertation, new methods to predict the mechanical and durability properties of expansive concrete are proposed. These methods were essential for the further development of the expansive concrete design.

Chapter 1 contains the background of this study, research objectives, the summary of the methods, and the structure of this dissertation.

Chapter 2 indicates the literature review results which contain important information about the shrinkage phenomenon in concrete, the origins and various studies on expansive concrete, and concrete durability assessments.

Chapter 3 explains the methods used in this study, covering the details of materials, specimen types, mixing procedures, curing conditions, and testing methods.

Chapter 4 contains the results and discussion parts. This chapter is most important in explaining the results obtained from the experiments and analysis, and it can be divided into the following four parts:

First, the expansion prediction model was developed using thermogravimetric modeling with Gibbs-energy minimization software of expansive pastes with various water-to-binder ratios (w/b) and expansive additive dosages. Thermodynamic modeling was used to estimate the hydration products including Portlandite, ettringite, etc. The accuracy of thermodynamic modeling was checked through the comparison with X-ray diffraction tests. The analysis was conducted to investigate the correlation between hydration products obtained from thermodynamic modeling and the strains of expansive mortars. The results indicated that it is possible to develop a simple model

to predict the expansive strain of cement products containing calcium sulfoaluminate (CSA)-based expansive additives based on the volume of ettringite produced by the hydration of CSA. The results were validated using mortars containing different types of cement and expansive concrete specimens.

Second, to understand the comprehensive effects of expansive additive dosages, w/b, and curing conditions on the performance of expansive concrete, cylindrical and prism specimens were cast with various expansive additives amounts and w/b. High dosages of the expansive agent and steam-curing treatment were applied to induce higher chemical prestresses in the concrete. Compressive strength and Torrent's air permeability measurements were performed to assess the mechanical and durability performances. The results indicate the effect of chemical prestresses on improving compressive strength; however, the air permeability performance generally suffers, which could be associated with microcracking. While steam-cured concrete experienced overall performance deterioration, supplying additional moisture could improve the air permeability but not the strength. Lowering the water-to-binder ratio was determined to be the most effective method for obtaining an improved performance for steam-cured chemically-prestressed concrete.

Third, the effects of specimen sizes, reinforcement ratios, and reinforcement arrangements on the mechanism of air permeability changes of expansive concrete were studied by conducting Torrent's air permeability test to non-destructively evaluate the disparity in air permeability changes of expansive concrete during the drying processes from 28 to 182 days. Additionally, expansive strain changes were continuously monitored to investigate chemical prestress. The experimental test results suggest the immense effect of the change in expansive strain on the air permeability of concrete. This study proposes that the change in microstructure owing to the loss of expansive strain may cause an increase in air permeability. The loss of expansive strain is a distinguished feature that differentiates the mechanism of air permeability changes in expansive and normal concrete. These findings suggest the possible improvement in the durability performance of expansive concrete in cases where the loss of its expansive strain can be controlled.

Finally, the information obtained from studies on different topics was combined to propose possible methods to predict the strengths and air permeability indices of expansive concrete. In the proposed models, compressive strength can be estimated based on the maximum chemical prestress data calculated from thermodynamic modeling. Meanwhile, the estimation of air permeability indices is conducted by inputting the shrinkage strain and the dosage of expansive concrete in the mixtures.

Chapter 5 summarizes all the significant results obtained from this dissertation and provides some recommendations for improvement in future studies.

The examining committee members evaluated that the dissertation met the standard of excellence expected of a doctoral candidate at Hiroshima University.

備考：審査の要旨は，1,500 字以内とする。