論文 / 著書情報
Article / Book Information

題目(和文)	ポルトランドセメント-アルミナセメント-セッコウ系多相材料の特性と強度発現機構
Title(English)	Properties and development of compressive strength of multi-phase material based on the Portland cement - calcium aluminate cement - calcium sulfate system
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Category(English)	Doctoral Thesis
種別(和文)	論文要旨
Type(English)	Summary

（博士課程）
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論 文 要 旨

THESIS SUMMARY

専攻： Department of	材料工学 専攻	申請学位（専攻分野）： Academic Degree Requested	博士 （ 工学 ） Doctor of
学生氏名： Student's Name	森 裕克	指導教員（主）： Academic Advisor(main)	坂井悦郎 教授
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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

Cementitious multi-phase material based on the Portland cement (PC) - calcium aluminate cement (AC) - anhydrite system (CS) enables us to reduce the construction labor and the period due to its high fluidity and rapid hardening. This thesis proposes methods to control the physical properties of the multi-phase material based on the PC-AC-$C\bar{S}$ system and examines the new mechanisms of developing compressive strength including the influence of the kind of hydrate. It also proposes cementitious multi-phase material with blast-furnace slag (BFS) added considering the environment and examined its application. The title of this thesis, which includes six chapters, is "Properties and development of compressive strength of multi-phase material based on the Portland cement - calcium aluminate cement - calcium sulfate system."

Chapter 1 "Introduction" presents the background of this study. The supply of skilled construction workers is expected to become tighter due to the Olympics emergency demand and disaster restoration, in addition to the recent decrease in the number of skilled construction workers. Therefore, demands for shortened construction periods, improved workability, and high durability of cementitious material will increase. The necessity of cementitious multi-phase material combining high fluidity, rapid hardening, and dimensional stability and the necessity of understanding the mechanism of developing compressive strength were also mentioned. The literature was arranged, and the purpose of this study and background were then indicated. In addition, the need to consider environment-friendly material by using by-products was indicated.

Chapter 2 "Control of the physical properties of cementitious multi-phase material" reported that the fluidity could be controlled by the packing fraction of powder developed in packing simulation.Rapid hardening and dimensional stability were found to be related with the amount of ettringite and could be controlled by the SO_3/Al_2O_3 mol ratio in the multi-phase material. In cementitious multi-phase material, the mix proportions could be chosen depending on required performance. However, the difference of the compressive strength of the multi-phase material based on the PC-AC-$C\bar{S}$ system generally could not explain by the difference of the porosity in conjunction with the compressive strength.

Chapter 3 "Analysis of the physical properties of hydrate by nanoindentation" clarified the kind of hydrates, and the physical properties of these hydrate were analyzed by nanoindentation to clarify the development mechanism for compressive strength. First, the phase composition of the hardened cement paste was determined by using the geochemistry code based on the thermodynamic equilibrium theory and on the reaction ratio of each raw material to clarify the hydrate formed in the multi-phase material based on the PC-AC-CS system. This thesis assumes that many amorphous hydrates were produced in this cementitious multi-phase material that could not be identified by normal analysis. Based on the phase composition, CH, C-S-H gel, AH_3gel, C-A-H gel, Ettringite, and Monosulfate were synthesized, and the hardnesses of these hydrates were analyzed by nanoindentation. The indentation hardness was found to differ with the kind of hydrate in the following order: CH, C-S-H gel, AH_3gel, C-A-H gel, Ettringite, Monosulfate.

Chapter 4 "Examination of the compressive strength development mechanism in the physical properties of hydrates and the phase composition of hardened cement paste" examined the technique proposed by Ryshkewitch to determine the influence of the kind of hydrate based on the equation ($\sigma = \sigma_0 \exp(-k*P)$), which describes the porosity dependence of compressive strength. σ_0 was considered to be the compressive strength, which is the arrival strength when the capillary porosity is 0. Therefore, we decided to use the hardness of the hydrate and the volume fraction in reference to the parallelism flat board model, which expresses the properties of the composite material by the properties and volume fraction of each component for calculating σ_0. In addition, the k value, which expresses the porosity dependence of compressive strength, calculated from the relationship between σ_0 calculated by the above method and the actual compressive strength and porosity. Furthermore, to predict the k value from the phase composition, the k value expression was examined with multiple-regression analysis using the above k values and the volume fraction of the hydrate. The compressive strength predicted from the Ryshkewitch equation using σ_0 and k values calculated by the above method had a high association with actual compressive strength and clarified that the physical properties of the hydrate and the phase composition of the cement paste influenced the development of the compressive strength of the multi-phase material.

Chapter 5 "Properties and application of cementitious multi-phase material considering the environment" examined the cementitious multi-phase material containing much BFS. The fluidity was related to the packing fraction of powders, even in a system using blast-furnace slag. Furthermore, rapid hardening and dimension stability were related to the SO_3/Al_2O_3 mol ratio in the multi-phase material. It was also clarified that the compressive strength could be estimated by the method of Chapter 4. Furthermore, self-leveling material, in which high fluidity and rapid hardening greatly reduced the construction period and labor cost, was examined. The self-leveling material developed in this study had high fluidity and rapid hardening at the construction site. The CO_2 discharge of the multi-phase material developed in this chapter was half when we used the PC-AC-$C\bar{S}$ system and two-fifths when we used only ordinary Portland cement.

Chapter 6 "Conclusions" summarizes the knowledge and results from each chapter.

備考 ： 論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 1 部提出してください。
Note : Thesis Summary should be submitted in either a copy of 2000 Japanese Characters and 300 Words (English) or 1copy of 800 Words (English).