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学　位　論　文　内　容　の　要　旨

博士の専攻分野の名称　　博士（工学）　　氏名　戸田賀奈子

学　位　論　文　題　名

Key factors affecting the pozzolanic reaction of steel slag-dredged soil mixtures -From inorganic and organic perspectives-

(浚渫土-製鋼スラグ混合土のポゾラン反応の鍵となる影響因子 -特に無機・有機の観点から-)

Industrial byproducts and waste soils are environmentally low-impact resources for the construction industry. Construction materials made with such resources are particularly attractive for regional use close to the material sources, because of the feasibility in the transport and application associated with cost savings. Dredged soils, excavated sediments of water ways, and steel slags, byproducts of iron making processes, have potential to form civil engineering constructions close to seashores, as their mixtures develop strength. The utilization of such mixtures is still limited due to their unpredictable variation of strength development when different dredged soils or steel slags are applied. No previous studies have comprehensively investigated the key factors which affects the strength development of the mixtures. This study elucidates the key factors for the first time by identifying the contributions of both inorganic and organic components in steel slags and dredged soils to the strength development of the mixtures.

Chapter 1 reviews the literature on the general management of dredged soils and steel slags, current knowledge of technologies on their validation as construction materials, as well as the pozzolanic reaction, chemical reaction that develops strength of the mixtures, to identify the factors affecting the reaction.

Chapter 2 focuses on identifying the factors among inorganic components in dredged soils and steel slags affecting the strength development of the mixtures. Amorphous silica in dredged soils and portlandite in steel slags were identified as the key factors as major Si and Ca sources for the pozzolanic reaction, respectively.

Chapter 3 focuses on identifying the effect of organic components in dredged soils to the strength development of the mixtures. Characteristics of dredged soils such as high sulfur content in soil organic matters fraction exhibited the soft mixtures, which suggested the strength development inhibition by soil organic matters. Chapter 2 and 3 newly show that the quantification of particulars in inorganic and organic components of raw materials indicate the strength development of the mixtures. Discovery of the indicators would facilitate the evaluation processes of the applicability of the mixtures to constructions.

Chapter 4 experimentally proofs the inhibition of the pozzolanic reaction by soil organic matters, by designing an experiment of the pozzolanic reaction in coexistence of escalating amount of a model

organic matter. The inhibition of the pozzolanic reaction with a threshold in the dosage of the organic matter indicated a dosage of some soil organic matters to inhibit the strength development of soft mixtures, as speculated in chapter 3.

Chapter 5 experimentally compares the effectiveness of soil organic matter reagents to the inhibition of the pozzolanic reaction. Organic reagents caused the inhibition of the pozzolanic reaction at different dosages. Together with the characterization of the organic reagents, this study suggests that the dosage of reduced sulfur and/or phenolic groups may trigger the inhibition of the pozzolanic reaction. Chapter 4 and 5 newly show that the soil organic matters inhibit the pozzolanic reaction.

Chapter 6 characterizes the bulk soil organic matters extracted from dredged soils, to identify particulars that may affect the pozzolanic reaction in the mixtures. The sulfur indicator of soft mixtures, stated on chapter 3, was found to result from the difference in the content of reduced sulfur. Discoveries in chapter 5 and 6 suggest reduced sulfur as a key component that plays a role in the inhibition of the pozzolanic reaction.

Chapter 7 focuses on clarifying the interaction of soil organic matters with the pozzolanic reaction under microscopic scales. Additional to reduced sulfur and phenolic groups, the X-ray spectroscopic study on the distribution of carbon speciation in the mixtures and the synthesis products of the pozzolanic reaction suggested aromatic carbon to affect the pozzolanic reaction, as it selectively coexisted with the samples which the pozzolanic reaction was inhibited.

Chapter 8 concludes the key factors that affect the strength development of the mixtures in the context of waste validation and shows research impact. Outstanding insights are derived from half-splitting analysis of key components in raw materials that promote and inhibit geochemical reactions in control of strength development of such construction materials. These findings in this study are unambiguously useful to enhance utilization of industrial byproducts and waste soils in the construction industry.