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CALTRANS DIVISION OF RESEARCH, INNOVATION AND SYSTEM INFORMATION

Research Notes

Implementation of advanced technology and materials recycling techniques for use of alternative materials in concrete as plain or reinforced materials

Conduct risk-benefit analysis and evaluate performance of alternative supplementary cementitious materials for use in concrete

Geotechnical/ Structure

MAY 2024

Project Title:
Implementation of advanced technology and materials recycling techniques for use of alternative materials in concrete as plain or reinforced materials

Task Number: 3800

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WHAT IS THE NEED?

The California Department of Transportation (Caltrans) employs a variety of cementitious materials for development of concrete mixtures used in structural and pavement applications. Materials and construction account for approximately 25% of all greenhouse gas (GHG) emissions for the life cycle of a concrete bridge or pavement of which cement alone accounts for two-thirds of that impact. Caltrans procures over one million cubic yards of concrete every year. Alternative materials used to replace cement, beyond what the Department already mandates, can significantly reduce the GHG emissions that the Department has set out to achieve.

Conventional Supplementary Cementitious Materials (SCMs), such as fly ash or blast furnace slag have been used by the construction industry for many decades. A large body of knowledge has been collected regarding the effect of such SCMs on properties of concrete in fresh and hardened states, as well as their contribution in reducing the carbon footprint in concrete construction. As the supply of traditional SCMs becomes more restricted and the demand for SCMs to reduce GHGs is increasing, the search for new sources of SCMs becomes a priority. Caltrans is interested in identifying alternative SCMs that could serve as an alternative to the currently available options on Department's Authorized Materials List (AML).

WHAT ARE WE DOING?

The work will include a survey of literature on recent progress on production and use of alternative SCMs in concrete construction. The research team will investigate the estimated volume of materials available for each source, along with the average shipping distance to California. The team will perform the initial resource analysis to offer an overview of the chemical composition and physical properties of the materials, in comparison with traditional SCMs and current Caltrans requirements. Treatment steps necessary for processing and beneficial use needs to be clarified based on laboratory investigations. The team will also investigate the effect of selected alternative SCMs on the mechanical properties and durability of concrete designated for Caltrans applications.

WHAT IS OUR GOAL?

The goal of this research is to perform a risk-benefit analysis and performance evaluation to support or refute adoption of innovative advanced alternative materials in concrete, and to provide opportunities for adding more SCM resources to the existing AML.

WHAT IS THE BENEFIT?

The use of these alternative and recycled materials can reduce energy consumption and GHG emissions. It also minimizes the impacts of construction, decreases the depletion of natural resources, and meets legislative mandates. Identifying more resources that meet the Caltrans' technical requirements will also add flexibility to the supply and contribute to reduced cost of the concrete materials.

WHAT IS THE PROGRESS TO DATE?

As of May 2024, the research team has made the following progress: completed the literature review report; identified and obtained 37 A-SCMs within California; finalized the work plan for the project; characterized obtained materials for oxide composition using XRF analysis and specific gravity using a pycnometer; performed reactivity test for the obtained materials using the pozzolanic reactivity test (PRT); and tested the model applied to A-SCMs by simulating the performance of 4 materials. In addition, water admixture absorption testing for all the materials as well as the heat of hydration studies are nearly completed.