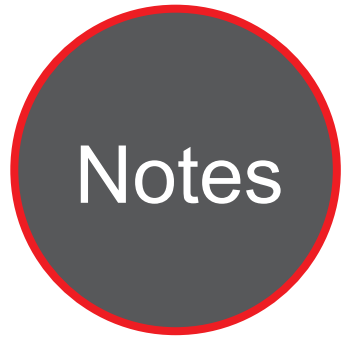




Caltrans Division of Research,
Innovation and System Information

Research



Notes



Geotechnical/
Structure

FEBRUARY 2023

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

Start Date: July 1, 2022

Completion Date: September 30, 2024

Task Manager:
Weili Zhao
Transportation Engineer
weili.zhao@dot.ca.gov

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

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).



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California's transportation system

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 material available for each source, along with the average shipping distance to California.

Initial resource analysis will be performed 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 effect of selected alternative SCMs on mechanical properties and durability of concrete designated for Caltrans applications will also be investigated.

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 (specifically harvested fly ash, class C ash and recycled glass) in concrete. This can provide opportunities for adding more SCM resources to the existing AML, which helps Caltrans avoid potential shortages in SCM resources, and adds more flexibility to the supply of SCMs.

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 February 2023, the research team has made the following progress:

- Literature Review report was completed. The draft literature review document was submitted to Caltrans in Nov 2022.
- 37 A-SCMs near the California region have been identified. Interviews were conducted with sources and materials obtained.
- The work plan for the project was finalized.
- The materials obtained were characterized for oxide composition using XRF analysis and specific gravity using a pycnometer.
- Characterization of reactivity of the materials received is being performed using the pozzolanic reactivity test (PRT).
- The model has been tested for applying to A-SCMs by simulating the performance of 4 materials.
- The equipment for determining water demand of materials has been designed and setup.