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CALTRANS DIVISION OF RESEARCH, INNOVATION AND SYSTEM INFORMATION

Research Notes

Developing A Framework for the Assessment and Implementation of Innovative Concrete Construction Materials

Develop a comprehensive and streamlined framework that empowers Caltrans to efficiently identify and assess technically sound, environmentally sustainable, and economically feasible materials

Geotechnical/ Structures

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Project Title:
Developing A Framework for the Assessment and Implementation of Innovative Concrete Construction Materials

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WHAT IS THE NEED?

As a state, California is one of the largest consumers of cement in the United States (U.S.), second only to Texas. California is also a major producer of cement. The direct emissions from the seven cement plants in California contributed 7.8 million tons of CO2-eq emissions in 2019. One of the largest sources of demand for cement in the state is the construction of streets, highways, and other transportation infrastructure. Recognizing the need to reduce greenhouse gas (GHG) emissions associated with concrete pavement and bridge construction, Caltrans aims to decrease portland cement consumption. Recently, innovative materials have been developed and produced at various scales to replace a portion of portland cement in concrete while improving durability.

However, the challenge lies in rapidly and comprehensively assessing these new materials to develop appropriate specifications and implement them quickly and effectively, including sufficient assessment of the functional performance risks. The wide variety of raw materials, activation methods, and treatment techniques result in diverse physical and chemical properties, all of which can impact concrete differently, further complicating the assessment process. Hence, it becomes crucial for Caltrans to develop a technology-agnostic assessment framework. Such a framework will facilitate a swift and thorough evaluation of emerging materials, enabling prompt approval and adoption of innovative solutions that are likely to be successful. This, in turn, will avoid project delays and advance efforts to reduce GHG emissions associated with concrete materials.

WHAT ARE WE DOING?

The research work will be performed in three phases. The first phase of the research work will begin by engaging with a wide

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range of suppliers of supplementary cementitious materials (SCMs) that produce SCMs from diverse sources, such as volcanic ash, pumices, perlites, diatomaceous earth, and calcined kaolinite clay, biomass ashes, within the state and across the U.S. In addition, producers of novel cements and engineered SCMs by start-ups, innovators, and emerging companies in carbon utilization in concrete will also be involved.

By engaging with these diverse stakeholders, the research team aims to create a comprehensive and effective framework for a rapid and comprehensive assessment of emerging materials and technologies, ultimately helping advance sustainability and innovation within the cement and concrete industry. In addition, all relevant standards and standard specifications from across the United States and Europe will be reviewed to compile a list of relevant tests for the assessment of cements and SCMs.

The first phase will be concluded by producing two technical memorandums that (1) categorize available technologies into groups based on similar materials and methodologies, and (2) provide a guide for the technical assessment of the identified SCMs and cements. The guide will be based on relevant AASHTO or ASTM specifications if available.

The research work in phase 2 will develop a comprehensive technology-agnostic assessment and implementation framework by performing an assessment of the technology readiness level of the materials/products compiled and synthesized in Phase 1. The framework will include an assessment of the known chemical/physical characteristics, evaluation of production capacity and availability, determination of the applicable test methods for small-scale evaluation, and evaluation of the scalability and the ability to produce the technology on a larger scale. Phase 2 will conclude with a presentation of the draft framework to Caltrans and other industry material/product stakeholders. Their feedback will be reflected in the final framework.

In the final phase of the research work, a comprehensive final report will be produced, incorporating the refined step-by-step framework for identifying suitable SCMs for Caltrans. The report will also outline the pathway for implementation, including demonstration examples showcasing the application of the process for one or two innovative materials.

WHAT IS OUR GOAL?

The goal of this project is to create a comprehensive and streamlined framework that empowers Caltrans to efficiently identify and assess technically sound, environmentally sustainable, and economically feasible materials that ultimately reduce greenhouse gas (GHG) emissions associated with concrete pavement and bridge construction.

WHAT IS THE BENEFIT?

Recognizing the need to reduce greenhouse gas (GHG) emissions associated with concrete pavement and bridge construction, Caltrans aims to decrease portland cement consumption. The research work will facilitate a swift and thorough evaluation of emerging materials, enabling prompt approval and adoption of innovative solutions that are likely to be successful. This, in turn, will avoid project delays and advance efforts to reduce GHG emissions associated with concrete materials.

WHAT IS THE PROGRESS TO DATE?

The contract for this task order was executed on February 15, 2024, and the kick-off meeting was held on February 28, 2024. The first deliverable is a technical memorandum categorizing available technologies into groups based on similar materials and methodologies.