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CALTRANS DIVISION OF RESEARCH, INNOVATION AND SYSTEM INFORMATION

TRANSFORMING IDEAS INTO SOLUTIONS

Research Results

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

Develop a comprehensive and streamlined framework that empowers California Department of Transportation (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 WAS 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. 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 would 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.

Caltrans

DRISI provides solutions and knowledge that improves California's transportation system.

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WHAT WAS OUR GOAL?

The goal of the project was 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 GHG emissions associated with concrete pavement and bridge construction.

WHAT DID WE DO?

The research work was performed in three phases. The first phase of the research work began by engaging with a wide 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 were also contacted, where applicable. All relevant standards and standard specifications from across the United States and Europe were reviewed to compile a list of relevant tests for the assessment of cements and SCMs.

The research work in phase 2 developed 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 included 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.

In the final phase of the research work, a comprehensive final report was produced, incorporating the refined step-by-step framework for identifying suitable SCMs for Caltrans. The report also outlined the pathway for implementation, including a demonstration example showcasing the application of the process for an innovative material.

WHAT WAS THE OUTCOME?

The final report introduced a structured evaluation framework, "Lab2Slab2Practice," aimed at accelerating the adoption of new materials and technologies. Key strategies include leveraging social- behavioral-change models, such as the Unified Theory of Acceptance and Use of Technology and Kotter's 8-Step Change Model, to mitigate risks and facilitate adoption. A comprehensive review of prior successful government programs and initiatives, including AASHTO's Superpave and Pavement Mechanistic-Empirical Design tools, underscored the importance of interagency collaboration and support, rapid experimentation, theoretical simulations, and engagement by owners (primarily departments of transportation), contractors, and other stakeholders. Regional centers are proposed as clearinghouses to systematically evaluate materials across Technology Readiness Levels, emphasizing engineering performance, scalability, and constructability. Public-private coalitions are proposed to fund these centers, ensuring transparent dissemination of findings and stakeholder training.

WHAT IS THE BENEFIT?

Recognizing the need to reduce 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.

LEARN MORE

Final Report Title

Lab2Slab2Practice: A Framework for a Faster Implementation of Innovative Concrete Materials and Technology

Permalink: https://escholarship.org/uc/item/7px6m-4wx