DRISI
Caltrans Division of Research, Innovation and System Information

Research Notes

Pavement

Tools To Increase Material Efficiency Of Cement

Create tools to inform selection of desirable concrete mixtures for transportation systems to reduce greenhouse gas emissions.

NOVEMBER 2019

Project Title:
Transformation of Engineering Tools to Increase Material Efficiency of Concrete

Task Number: 3327

Start Date: January 1, 2020

Completion Date: December 31, 2020

Task Manager:
Junxia Wu
Transportation Engineer
junxia.wu@dot.ca.gov

WHAT IS THE NEED?

Reducing greenhouse gas emissions from energy demand and material production is of great concern in California and around the world. Concrete, the second most used material after water globally, is responsible for 8% of all greenhouse gas emissions worldwide. The primary binder in concrete is cement, which is among the most difficult materials to decarbonize, a function of how the material is made.

However, it is not a material that is easily replaced. For modern infrastructure, cement is a critical component, and to meet the needs of growing populations, California is the second largest producer of cement in the United States.

Due to large transportation infrastructure demands in California, California Department of Transportation is the largest single consumer of cement in the state. The state-of-practice focuses on the use of cement and other individual constituents of concrete at single points in time, but overlooks how multiple components interact and how material longevity can affect environmental and monetary costs.

This convention can lead to inefficient use of materials in transportation systems. As such, there is an urgent need to improve design and selection tools to facilitate efficient use of cement and concrete. By reducing the demand of these materials through informed design, reductions in burdens on the environment can be achieved.

WHAT ARE WE DOING?

The research team will develop tools to inform selection of concrete mixtures for specific needs, assess the effects of steel reinforcement on greenhouse gas emissions, and identify the potential environmental benefits from improved material longevity. To this end, research will be conducted in three main phases:

1. Formulation of life cycle inventories and life cycle assessments for concrete to provide a database for informed decision-making.
2. Formulation of multi-criteria selection tools for selecting appropriate amounts of cement in concrete mixtures and tools for efficient design of concrete based on performance with other materials (in the proposed work, focus will be on design with steel rebar).
3. Formulation of models to assess the effects of material longevity on improved sustainability of concrete transportation infrastructure systems.

WHAT IS OUR GOAL?

This study will lead to development of robust datasets and decision-making tools to better engineer low environmental burden concrete systems. Findings can be used to inform infrastructure decisions as well as permit comparisons of most efficient improvements.

WHAT IS THE BENEFIT?

Improved concrete design tools and improved use of concrete can reduce greenhouse gas emissions in California. The research findings will be used to inform how performance variables can be used to target materials selection and benefit the design of concrete infrastructure systems. It will also aid public and private decision makers in guiding policy and planning decisions for concrete production and use.

WHAT IS THE PROGRESS TO DATE?

This task order will be executed on January 1, 2020. Professor Sabbie Miller at UC Davis will be the main investigator to perform the scoped research work.