Life Cycle Assessment (LCA) Updates and Applications

Improvements to Caltrans' environmental Life Cycle Assessment for Pavements (eLCAP)

Pavement

JANUARY 2022

Project Title:
Life Cycle Assessment (LCA) updates and applications

Task Number: 3191

Start Date:

Completion Date: January 2022

Task Manager:
Simon Bisrat
Senior Environmental Planner
simon.bisrat@dot.ca.gov

WHAT WAS THE NEED?

The California Department of Transportation (Caltrans) has a growing need to be able to quantify its greenhouse gas (GHG) emissions and the other environmental impacts of pavement operations, and to consider GHG and those other impacts in pavement management, conceptual design, design, materials selection, and construction project delivery decisions. Caltrans also needs to be able to evaluate the life cycle environmental impacts as part of policy and standards development. All these tasks can be performed using life cycle assessment (LCA), though there are different constraints and requirements with respect to the scope of the LCA and the data available for each of these different applications.

Caltrans currently uses the PaveM asset management software for pavement management. This software includes models for roughness, in terms of the International Roughness Index (IRI), that are used with previously developed life cycle inventories (LCIs) to calculate GHG emissions at the network level for planned scenarios of treatments versus "do nothing."

Caltrans is also currently using some simple spreadsheet-based LCA tools from the Federal Highway Administration (FHWA) called the Infrastructure Carbon Estimator (ICE) and LCA Pave. ICE functions at the corridor or higher level with very little input by the user. The data and models used to build the LCA Pave are mainly based on US averages.

There is a need for an LCA tool that models the details of the construction and maintenance life cycle of a pavement project at the conceptual-design stage or later in the project-design process. In addition, there is a need for a project-level LCA

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

tool that uses LCIs specific to the materials and equipment typically used in California and by Caltrans. To address these needs, the web-based software eLCAP was developed. eLCAP is being designed so that it can also produce conceptual project-level evaluations with California-specific data in the future.

WHAT WAS OUR GOAL?

The goal of this study is to continue the development of a web-based online pavement LCA tool that uses California-specific datasets for energy and material and that follows Caltrans construction practices. The tool will be updated using information developed by the University of California Pavement Research Center (UCPRC) for Caltrans in previous projects (4.66: Environmental Life Cycle Assessment Updates and Applications and 4.73: Fast Model Energy Consumption Structural Response) and the companion project in the current contract (4.80: Environmental LCA Updates and Applications). The tool will be consistent with the Federal Highway Administration (FHWA) Pavement Life Cycle Assessment Framework and the work of federal agencies (including FHWA) in the Federal Commons initiative.

WHAT DID WE DO?

The work was accomplished in the following subtasks:

Subtask 1: Update eLCAP with improved and new models at every pavement life cycle stage.
Subtask 2: Implement a conceptual design-level module for roadway analysis.
Subtask 3: Update the user interface and system requirements.
Subtask 4: Implement eLCAP after review and testing by UCPRC and Caltrans.
Subtask 5: Submit the tool for outside critical review and respond to comments.
Subtask 6: Update the software, software documentation, and help system.

WHAT WAS THE OUTCOME?

The web-based software environmental Life Cycle Assessment for Pavements (eLCAP) is a project-level LCA tool that uses California- and Caltrans-specific life cycle inventories (LCIs) and processes. The LCI database has been critically reviewed by outside experts following ISO standards. eLCAP models the life cycle history of a pavement project by allowing a user to specify any number of construction-type events, occurring at a user-specified date, followed by an automatically generated Use Stage event that begins immediately afterward and lasts until the next construction-type event or the end-of-life date. The Use Stage models currently consider the effects of roughness in terms of International Roughness Index and use the same performance models that are used in the Caltrans pavement asset management system software, PaveM. eLCAP performs a formal mass-balancing procedure on a pavement LCA project model and then computes 18 different impact category values—including Global Warming Potential, Human Health Particulate Air, Acidification, and different forms of Primary Energy—and generates a detailed Excel report file to display graphs and tables of results. The results can be presented in terms of life cycle stage, material types, and other details.

WHAT IS THE BENEFIT?

The eLCAP tool will allow Caltrans to consider GHG and those other impacts in pavement management, conceptual design, design, materials selection, and construction project delivery decisions. This will reduce Caltrans environmental footprint when considering transportation projects.

LEARN MORE

https://escholarship.org/uc/item/9f5181j1