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Research Results

Pavement

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Project Title:
Life-Cycle Cost and Environmental Life-Cycle Analysis for Composite Pavements

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Life-Cycle Cost Analysis for Composite Pavements

Composite pavements can be a cost-efficient alternative to rigid pavements

WHAT IS THE NEED?

Composite pavement consists of a rigid portland cement concrete structure, either jointed or continuously reinforced, covered with a flexible asphalt concrete layer. By adding an asphalt layer, it is possible to reduce the thickness of the portland cement layer—or extend the life of the typical thickness—because the asphalt surface reduces the differences in temperature between the top and bottom of the concrete that contribute to cracking. Caltrans has a documented design procedure for applying asphalt overlays on aged, cracked concrete pavement for maintenance and rehabilitation, but a comprehensive procedure is not available for designing new composite pavement.

The Caltrans Highway Design Manual requires that all major pavement projects use life-cycle cost analysis (LCCA) to determine the most appropriate and cost-effective pavement type for a location. To perform an accurate LCCA requires a variety of information, such as cross-sectional structures, construction schedules in terms of the number of lane closures and duration, traffic volume performance, unit costs, quantities of materials, and knowledge of future maintenance and rehabilitation requirements.

WHAT WAS OUR GOAL?

The goal was to investigate the effect of composite pavement design variables and incorporate the results into Caltrans design procedures and LCCA guidelines.

WHAT DID WE DO?

Caltrans worked with the University of California Pavement Research Center to analyze the use of composite pavements for typical highway segments, taking into account the region's

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climate, volume of truck traffic (measured as a traffic index or TI), soil type, and lateral clearance. The researchers calculated the cracking performance of different thicknesses of the concrete structure with .02-foot asphalt surface for different Tis over the design life of 40 years using mechanistic-empirical (ME) design software and compared the performance to the original thickness of rigid concrete without an asphalt overlay, with respect to their initial construction costs.

WHAT WAS THE OUTCOME?

The ME simulation showed that the rigid layer can be reduced when adding a 0.2-foot asphalt overlay, and the reduction increases for the thicker layers used for higher TIs. The rigid pavement begins slab cracking after it loses full friction, on average after about 136 months, whereas for the composite pavement, cracking begins from the initial age. Although slab cracking for composite pavement appears faster than the rigid pavement between 24 and 34 years, by the end of the 40-year design life, the slab cracking percent of the rigid pavement is higher than the composite pavement for all pavement and climate conditions. Composite pavement construction rates per lane-mile are initially higher than the rigid pavement for higher TIs. The number of closures for construction lane-miles for both pavement types are similar for TI 10, but the number of closures for composite pavement becomes slightly less with increased TIs.

WHAT IS THE BENEFIT?

Composite pavements can be a cost-efficient alternative to rigid pavements, but the information needed to compare their durability and performance for different traffic loads and climates was lacking. This research provides Caltrans pavement engineers accurate input values to analyze and compare the life-cycle costs of composite pavements.

IMAGES

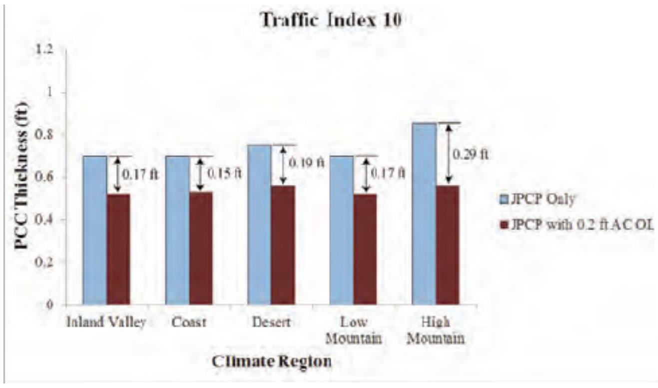

Figure 1: Thickness reductions for the different climate regions for TI 10

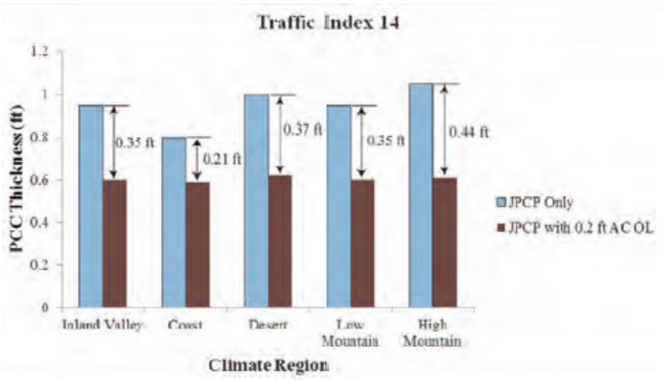

Figure 2: Priority freight regions and corridors in California

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