Designing for Sustainable Pavements

Problem

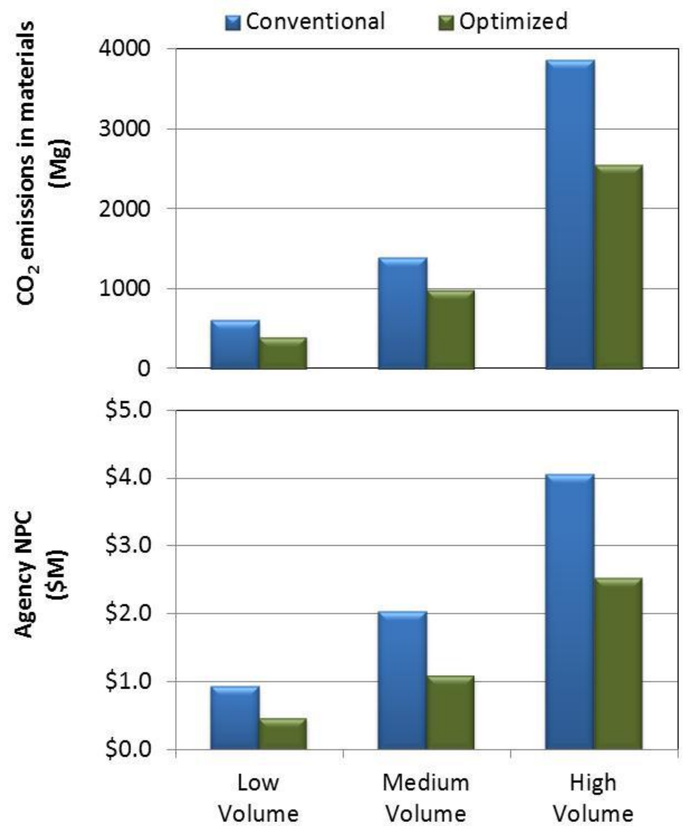
Increasing the sustainability of our infrastructure is accomplished in ways other than just developing better materials and more efficient processes: it is also about employing the right designs. For pavements, overdesign causes excess materials to be used during construction, leading to higher economic costs and environmental impacts. Optimizing design thicknesses for prescribed service lives, climates, and traffic conditions allows pavement engineers to create structures with minimal waste.

Approach

Advancements in design techniques allow for such optimizations. Pavement design tools, such as the National Cooperative Highway Research Program's *Mechanistic-Empirical Pavement Design Guide (MEPDG)*, use embedded models to forecast the propagation of various pavement distresses for combinations of materials properties and external parameters. MIT has developed three case studies to demonstrate the effect that design optimization can have on costs and CO_2 emissions. Conventional designs are compared against *MEPDG* designs for sample low-volume, medium-volume, and high-volume highways in California. The designs are evaluated over a 50-year analysis period using life-cycle assessment (LCA) and life-cycle cost analysis (LCCA) principles.

Findings

Optimized designs can provide significant economic and environmental benefits. For the three case studies, the optimized designs reduce agency net present cost (NPC) by roughly 40–50% and CO_2 emissions by roughly 30%. These are likely to be conservative estimates, as other life-cycle implications, such as shorter construction times and reduced transportation, are not considered in the current demonstrations studies. User costs due to traffic delay may also be reduced using optimized design thicknesses.



Using optimized designs helps reduce both embodied CO_2 emissions and net present value (NPC)

Impact

The use of optimized design thicknesses helps reduce costs and CO_2 emissions by minimizing the materials needed to construct a pavement. The economic and environmental benefits are significant and can help transportation agencies reduce their carbon footprint while working within tight budgetary constraints.

More

The research presented here is a part of an ongoing project by the pavements LCA team at the MIT Concrete Sustainability Hub. More information on the *MEPDG* model can be found at <http://www.trb.org/mepdg/>.

This research was carried out by the CSHub@MIT with sponsorship provided by the Portland Cement Association (PCA) and the Ready Mixed Concrete (RMC) Research & Education Foundation. The CSHub@MIT is solely responsible for content. For more information, write to CSHub@mit.edu.