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Well-Maintained Roadways Improve Fuel Efficiency

Research aims to encourage decision makers to think of infrastructure as part of the solution in a carbon constrained environment.

Cambridge, Mass., (February 29, 2016) – A collaboration between the MIT Concrete Sustainability Hub (CSHub) and the California Department of Transportation (Caltrans) showed that phenomena associated with pavement vehicle interaction (PVI), including roughness and deflection, accounts for one percent of overall fuel consumption on California highways.

"In an environment where we deal with carbon restriction and where carbon has a price, making it part of the equation — making it part of the cultural baggage of engineers to improve our infrastructure — is the ultimate focus, this where we want this research to end up," said MIT professor of civil and environmental engineering Franz-Josef Ulm, faculty director of MIT's Concrete Sustainability Hub (CSHub).

Caltrans provided CSHub researchers with a wealth of data collected using ground-penetrating radar. The data identified the road's structure, including the materials beneath the pavement, and included GPS coordinates on every crack, rut and bump in California's 50,000 lane-mile system. CSHub researchers employed a novel small-scale experimental approach in which a rigid steel tire rolls along a polymer pavement while they measure the horizontal force required to move the tire forward at different speeds and with different loads. This approach allowed them to look directly at the interaction between the wheel and pavement structure where many past PVI studies relied on actual trucks on actual pavement and ignored structure and material properties.

CSHub researchers ran 40,000 to 50,000 calculations for each mile in the network and then made a ranking to determine the fastest path reduction of fuel consumption. For each road, thanks to the GPS data, researchers knew the amount of traffic, the temperature, structural data, material data and GPS coordinates.

By feeding the data into the experimental model, the CSHub researchers were able to calculate excess fuel consumption and generate decision trees and modeling programs, which allowed Caltrans engineers to select the paving projects that will have the biggest impact on fuel savings, which also leads to a reduction in greenhouse gas emissions.

According to Ulm, a passenger car wouldn't achieve significant gas savings, but road stiffness could make an enormous difference for 40-ton trucks, with up to 4 percent gas mileage savings. Caltrans studies have already shown a 2 to 3 percent reduction in greenhouse-gas emissions in high-traffic volume locations.

This research comes at a time when tougher greenhouse gas policies are expected. Last December at an international climate action conference in Paris, 196 countries pledged to reduce carbon emissions. As a result, governments around the world are drafting new policies aimed at curbing their GHG emissions. The ultimate goal of the CSHub/Caltrans research is for decision makers, including engineers and politicians, to think of infrastructure as part of the solution in a carbon constrained environment.

CSHub research is not just focused the use phase, or just on PVI; it looks broadly at the entire life cycle of paving and building materials. The CSHub also has life cycle analysis (LCA) and LCCA projects in Virginia, Colorado, and Minnesota.

About the MIT Concrete Sustainability Hub

The Concrete Sustainability Hub (CSHub) is a research center at the Massachusetts Institute of Technology (MIT) that launched in 2009 in partnership with the Ready Mixed Concrete Research & Education Foundation and the Portland Cement Association (PCA). The CSHub comprises a dedicated team of interdisciplinary researchers from several MIT departments working on concrete and infrastructure science, engineering, and economics. It brings together leaders from academia, industry, and government to develop breakthroughs using a holistic approach that will achieve durable and sustainable homes, buildings, and infrastructure in ever more demanding environments.

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