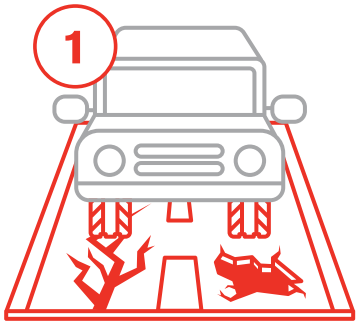
MIT CONCRETE SUSTAINABILITY HUB

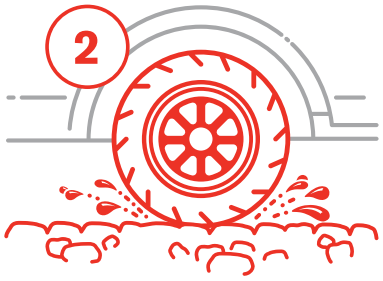
PAVEMENT VEHICLE INTERACTION

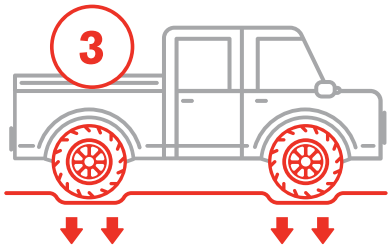
TO LEARN MORE: **CSHUB.MIT.EDU/PAVEMENTS/PVI**

Lowering Fuel Consumption and Emissions Through Better Pavement Design and Maintenance

All vehicles, whether gasoline, diesel, or electric, use energy to move—but some of that energy is wasted. The quality of the roads we drive on every day impacts the amount of fuel we use, as well as the associated greenhouse gas emissions. On roads where surface conditions are poor or structural properties are inadequate, vehicles consume additional fuel beyond what is needed to move. This wasted fuel is known as excess fuel consumption.







MIT Concrete Sustainability Hub (CSHub) researchers study pavement-vehicle interaction (PVI) in an effort to understand and quantify the impacts of excess fuel consumption. Our research focuses on three key factors:

1. **ROUGHNESS**: whether the road is bumpy or smooth. Roughness, commonly seen and felt as the presence of cracks and potholes, has a significant impact on passenger vehicles.
2. **TEXTURE**: the abrasiveness of the road surface, which relates to vehicle traction when the surface is wet.
3. **DEFLECTION**: the bending of a pavement under the weight of a vehicle. Deflection is present from the initial construction, and depends on pavement design. Think of the difference between walking or riding on sand versus a paved surface.

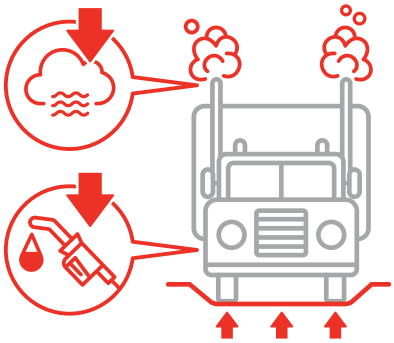
CSHub studies suggest that excess fuel consumption can be significantly reduced by building **stiffer** roads and maintaining **smoother** pavements. Doing so would benefit states, municipalities, and the communities in which we live through reductions in emissions and fuel costs to drivers. Improving road design and conditions yields fuel consumption and emission reductions for all road users, which results in instant environmental and economic payback.

This research was carried out by CSHub@MIT with sponsorship provided by the Portland Cement Association and the Ready Mixed Concrete Research & Education Foundation. CSHub@MIT is solely responsible for content. Published July 2018.

MIT CONCRETE SUSTAINABILITY HUB

PAVEMENT VEHICLE INTERACTION

TO LEARN MORE: **CSHUB.MIT.EDU/PAVEMENTS/PVI**



What other impacts–and potential savings–are involved?

Road stiffness is a particularly significant factor for 40-ton trucks, where lessening the impacts of deflection could generate up to 4 percent in fuel savings. At the aggregate level, 2 million tons of CO_2 per year in savings is achievable. As more efficient hybrid and electric power-trains become more common, eliminating vehicle engine losses, the contribution of PVI factors to truck excess energy consumption may increase to as much as 8 percent.

In addition, the life cycle environmental impacts related to excess fuel consumption are often higher than the impacts associated with pavement materials and construction.

EXCESS FUEL CONSUMPTION (EFC) CASE STUDY: QUANTIFYING FUEL WASTE ON U.S. ROADWAYS

The impacts of excess fuel consumption depend on a variety of factors, including location, traffic levels, pavement designs, and maintenance schedules. Two CSHub case studies examined real roadway networks in California and Virginia:

- **California**: Using data collected by the California Department of Transportation (Caltrans) through the use of GPS and ground-penetrating radar, CSHub researchers conducted an analysis of the state's entire 50,000 lane-mile system and found excess fuel consumption of 1 billion gallons over a 5-year period. The collaboration showed that PVI factors, including roughness and deflection, account for 2.5% of the overall fuel consumption on California highways.
- **Virginia**: A study of the Commonwealth's interstate highway system –some 5,000 lane miles in total–identified 1 million tons of CO_2 associated with EFC emissions over a 7-year period. Researchers also determined that only 1.3 percent of the interstate network is responsible for 10 percent of its total greenhouse gas emissions, meaning rehabilitation of those few lane miles could result in significant environmental improvements.

ABOUT MIT CONCRETE SUSTAINABILITY HUB

The MIT Concrete Sustainability Hub, CSHub, is a dedicated interdisciplinary team of researchers from several departments across MIT working on concrete and infrastructure science, engineering, and economics since 2009. The MIT CSHub 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.

To learn more, visit **https://cshub.mit.edu/**.

This research was carried out by CSHub@MIT with sponsorship provided by the Portland Cement Association and the Ready Mixed Concrete Research & Education Foundation. CSHub@MIT is solely responsible for content. Published July 2018.