In August 2012, the U.S. Department of Transportation (DOT) and the U.S. Environmental Protection Agency (EPA) issued standards with the intent to increase fuel economy to the equivalent of 54.5 mpg for cars and light-duty trucks by Model Year 2025. In total, these standards are anticipated to save consumers more than $1.7 trillion at the gas pump and reduce U.S. oil consumption by 12 billion barrels. In addition, in August 2011 the EPA and the DOT’s National Highway Traffic Safety Administration (NHTSA) announced a program to reduce greenhouse gas (GHG) emissions and improve fuel efficiency of heavy-duty trucks and buses. The agencies estimate that the heavy vehicle standards will reduce CO2 emissions by about 270 million metric tons and save about 530 million barrels of oil over the life of vehicles built for the 2014 to 2018 model years, providing $49 billion in net program benefits.

Since 1982, there have been numerous studies which demonstrate that vehicles traveling on concrete pavements experience 1% to 7% better fuel economy than when they travel on other pavement types. If the U.S highway network of approximately 8 million lane miles of pavement experienced an average improvement of just 1%, the result would equate to saving about 91 million barrels of crude oil per year, reducing annual costs by $5.2 billion and greenhouse gas emissions by 15.5 million tons of CO2.

It has long been understood that a vehicle’s reduced fuel consumption while traveling on a concrete pavement is due to the higher rigidity over flexible type pavements. However, a fundamental understanding of pavements and their interaction with the user’s vehicles has been lacking. Additionally, vehicle fuel consumption required to overcome resisting forces due to pavement-vehicle interaction (PVI) is an essential part of the use-phase impact of life-cycle assessments (LCA) of pavement systems.

Recently, the Concrete Sustainability HUB at MIT has developed a mechanistic model which links pavement structural and material properties to fuel consumption which contributes to closing the knowledge gap of PVI in pavement LCA.

MIT, using their PVI model, analyzed high-volume roadways and found that the contribution of both pavement deflection and roughness to added fuel consumption are significant (Fig. 1).
The impact of pavement deflection is more pronounced on asphalt pavements, while the impact of roughness on PVI is almost identical for asphalt and concrete (see the output from an example analysis in Fig. 2). When this type of analysis is applied to the U.S. highway network, MIT estimates that approximately 740 million gallons of excess fuel is consumed per year due to the use of flexible type pavements and the current condition of the network.

The MIT fuel consumption model demonstrates that both pavement roughness and deflection are highly important within the environmental analyses of pavement systems and greatly influence the aggregated vehicle fuel consumption. In concert with governmental policies requiring automakers to achieve better mileage standards, state DOTs could also reduce fuel consumption and greenhouse gas emissions by using concrete pavements. Further information about the MIT fuel consumption model is available at http://web.mit.edu/cshub/.

References

3. See NRMCA’s webpage on Sustainability to learn more about the LCA process (http://www.nrmca.org/sustainability/index.asp).