Talking Points: Paving Life Cycle Assessment

Report from the Massachusetts Institute of Technology’s Concrete Sustainability Hub: Methods, Impacts, and Opportunities in the Concrete Pavement Life Cycle

The U.S. network of streets, roads, and highways has significant environmental and economic impacts for the nation and the world.

- The United States has 8 million lane-miles of streets, roads, and highways, which carry more than 3 trillion vehicle-miles annually.
- This network requires 350 million tons of materials annually for maintenance and construction.
- Roads and the vehicles that use them contribute the most greenhouse gases of any transportation mode, accounting for 83% of emissions from the transportation sector.
- Overall, roads account for 27% of all greenhouse gas emissions in the U.S.

To better understand how roads contribute to or reduce greenhouse gas emissions, MIT researchers conducted a life cycle assessment (LCA) study to evaluate and improve the environmental impact of pavements.

- The study is a significant development for construction-related LCAs because it thoroughly examines the cost and environmental impacts over the entire life of pavements – including the use, operation, and end-of-life phases – not just the costs and embodied carbon dioxide that occur during production and initial construction.
- The use and rehabilitation phases can account for between 33% and 44% of the carbon dioxide emissions for Interstate highways.
- Researchers identified two strategies that significantly reduce the environmental impact of concrete pavement: increased fly ash and optimized design to use less material. The two strategies lowered the carbon footprint by about 10% and 17%, respectively, while also lowering initial construction costs.

MIT developed the first ever mechanistic pavement-vehicle interaction (PVI) model that relates fuel consumption to pavement material and structural properties.

- Researchers found that vehicles get better gas mileage on pavements with greater stiffness. If the pavement deflects or bends slightly under traffic loads, cars and trucks are running in a slight depression that increases fuel consumption. Pavements with greater stiffness produce less of a depression to roll out of and provide better fuel economy.
- MIT looked at typical material properties for concrete and asphalt pavements and found that to achieve the same stiffness and fuel consumption figures, asphalt pavement had to be about 60% thicker than concrete pavement.