MIT researchers evaluate the costs and environmental impacts of infrastructure

The Concrete Sustainability Hub at the Massachusetts Institute of Technology (MIT) has released two studies examining the life cycle assessment (LCA) of concrete pavements and buildings, and a third assessment on life-cycling costing for streets and highways.

The studies examine the cost and environmental impacts for the full life of pavements and buildings, including the use and operations phase, as well as the costs and embodied CO^2 that occur at initial construction. These studies represent major advancements for construction-related life-cycle assessments, as most LCAs in use do not fully account for these impacts (which can include traffic delays, energy consumption and maintenance).

Real cost of pavement

MIT also used this life-cycle approach to evaluate the real cost of pavement throughout a 50-year lifetime, beyond initial construction costs. The research showed that during a 50-year time frame, the mean real price of concrete decreases by 20%, while the mean real price of asphalt increases by 95%. To allow states to address this, MIT developed a paper and a procedure that departments of transportation can readily adopt to account for inflation.

Environmental impact

Furthermore, in its environmental assessment, MIT researchers found that while concrete pavements are already sustainable in many ways, their carbon footprint can be further reduced. MIT researchers developed a comprehensive methodology outlining the best-practice concepts that should be followed when conducting any pavement life-cycle assessment (LCA). Specifically, any complete LCA should include the use and rehabilitation phases, which can account for between 33% and 44% of the CO^2 emissions for interstate highways.

These concepts were applied to evaluate strategies to lower a concrete pavement's carbon footprint and overall environmental impact. A major advancement was the incorporation of a cost-effective analysis to determine whether or not a given environmental reduction strategy made sense economically. Among the strategies evaluated, the two that reduced embodied emissions (increased flyash and reduced overdesign due to better designs) were found to lower the CO^2 emissions by approximately 10% and 17%, respectively, while also saving upfront costs.

Fuel economy

Researchers additionally reviewed fuel economy from a unique perspective, analysing how pavement properties affect fuel economy rather than investigating the efficiency of cars and trucks. MIT developed the first-ever mechanistic pavement-vehicle interaction (PVI) model that relates fuel consumption to pavement material and structural properties. This model provides realistic estimates of changes due to deflection.

Pavements that deflect or bend slightly under traffic loads cause cars and trucks to run in a slight depression that increases fuel consumption. Pavements with greater stiffness result in better fuel economy for the vehicles that travel on them. With fuller development of this model, it will be possible to include the impacts of pavement properties and on fuel usage in both the environmental and cost analyses.

In addition, the research has quantified the relative CO^2 contribution from buildings across all phases of a building's life cycle. The analysis, with a similar study of whether the best environmental strategy was beneficial economically, will allow the construction industry to improve the accuracy and transparency of existing and future life cycle assessments.

Reports on the studies can be assessed via the CSHub website.

Adapted from press release by Rosalie Starling

Source: World Cement