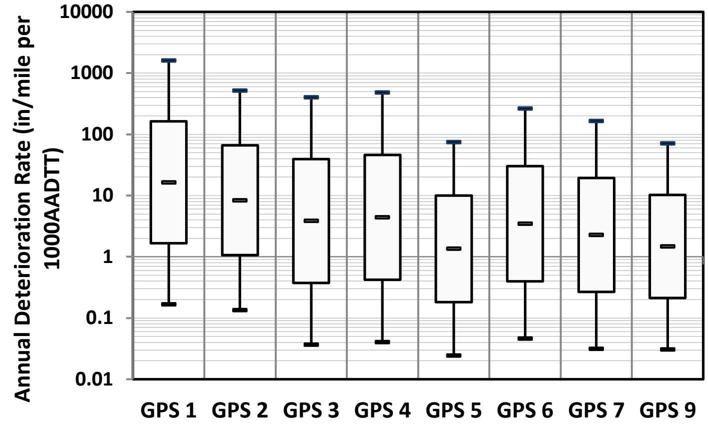
Deterioration Induced Roughness in the US Network

Problem

Reducing the environmental and economic footprint of the roadway transportation system requires a clear understanding of the state of the pavement network. Pavements in a network will vary in structure and material and are subject to various climatic and traffic settings. Pavement performance and deterioration rate thus vary extensively throughout the network. Methodologies are available to analyze the environmental and economic performance of pavements. These can be exercised in decisions for design and operation of specific pavement sections, but a network adaptation is necessary to capture the strengths, weaknesses, and opportunities of the pavement network. Our previous research focused on the current state of the roadway network and the distribution of the international roughness index (IRI) in this system. It was shown that IRI distributions for asphalt and concrete pavements are statistically equivalent. That is, at the national scale, distributions of IRI are similar for different pavement systems, which reflects that the DOT maintenance guidelines and rehabilitation criteria govern pavement IRI. While total IRI measurements serve as a backbone for maintenance decisions, how often such maintenance is required calls for an analysis of the change of IRI in time considering the impact of pavement design and durability.

Approach

Here, we consider roughness and its progression rate on eight pavement types from the General Pavement Studies (GPS) sections of the Long Term Pavement Performance (LTPP) program. Traffic data for the same sections are used from this database as well. To study the impact of pavement type on pavement deterioration, distributions of roughness progression rate are calculated for GPS's eight pavement types in terms of $\Delta IRI/\Delta t$, where ΔIRI is the change in roughness for a given change in time Δt. This is the time between the IRI measurements on each section, typically each year. Since different pavements carry different traffic volumes, the impact of loading on pavement deterioration has to be taken into account. This is achieved by normalizing roughness progression rate with respect to the annual average daily truck traffic volume, AADTT.



Log-normal distribution of the annual roughness progression rate normalized to AADTT for 8 pavement types: GPS-1: AC on granular base; GPS-2: AC on bound base; GPS-3: jointed plain CP; GPS-4: jointed reinforced CP; GPS-5: continuously reinforced CP; GPS-6: AC on AC; GPS-7: AC on CP; GPS-9: CP on CP. (AC: asphalt concrete, CP: concrete pavement). Data extracted from the LTPP databases standard data release #25. Data show one (box) and two (bars) standard deviations from the mean, shown by a dash mark.

Findings

The ranges of normalized roughness progression rate are shown in the figure. Although IRI distributions for the 8 pavement types are similar, the pavements perform differently when their deterioration rates are considered. Pavements with more structural support have slower mean and minimum deterioration rates. Asphalt pavements perform better with a bound base, continuously reinforced concrete pavements have the lowest deterioration rate, and there are orders of magnitude differences in the performance of these pavement systems in the network.

Impact

Pavement material and structural design directly influence pavement performance and its deterioration rate. Pavements with slower deterioration rates require fewer maintenance activities to meet agency IRI guidelines and will have lower environmental impacts within the pavement lifecycle. Analysis of PVI roughness, its progression, and its impacts at a national level can guide design and policy for sustainability of the US roadway network.

More

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This research was carried out by the CSHub@MIT with sponsorship provided by the Portland Cement Association (PCA) and the Ready Mixed Concrete (RMC) Research & Education Foundation. The CSHub@MIT is solely responsible for content. For more information, write to CSHub@mit.edu.