PROJECT SUMMARY

Texas Department of Transportation

0-6808: Quantification of the Impact of Roadway Conditions on Emissions

Background

Roads in poor condition not only decrease driver comfort, but also affect traveling speed and result in increased user costs, especially in fuel consumption, vehicle damage, and travel time. Due to limited funds, maintenance and rehabilitation treatments are often deferred for short-term cost reduction, although in the long term, this approach has negative effects on the road condition and on air quality.

What the Researchers Did

The research team studied the relationship between pavement condition and vehicle gas emissions, and compared the effectiveness of maintenance rehabilitation treatments to reduce gas emissions. Gas emissions collected for CO, CO_2, HC, and NO_x with the Portable Emission Measurement System (PEMS) at different pavement conditions and vehicle speeds in sections located in Austin, Bryan-College Station, El Paso, Houston, and San Antonio. The statistical analysis included stratified data charts by pavement condition, regression analysis, and hypothesis tests to study the effectiveness and potential gas emission savings of Preventive Maintenance (PM), Light Rehabilitation (LRhb), Medium Rehabilitation (MRhb), and Heavy Rehabilitation (HRhb) treatments. Current policies of the Federal Highway Administration (FHWA) and TxDOT management efforts related to environmental regulations were reviewed to provide recommendations for environmentally friendly pavement preservation strategies.

What They Found

It was concluded from the statistical analyses that pavements in better condition have lower IRIs and generate lower gas emissions. The equation to quantify vehicle gas emissions (g/mile) is:

$$\text{Vehicle Gas Emissions (g/mile)} = m * \text{IRI (in/mile)} + b$$

The parameters for CO_2, CO, HC, and NO_x gas emission equations in terms of IRI are summarized in Table 1.

What This Means

Findings from this study will allow TxDOT to incorporate gas emissions equations into network-level decision-making tools to demonstrate the positive impact of environmentally friendly strategies needed to preserve the roads in good condition. The timing of maintenance has a significant influence on treatment effectiveness. Table 2 shows a summary of the maximum potential savings on gas emissions for asphalt and

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concrete pavement treatment categories.

It must be noted that vehicle gas emissions depend not only on pavement condition, but also on a number of other factors, including vehicle type, vehicle dynamics, ambient temperature, vehicle age, fuel type, vehicle speed, and acceleration (deceleration). Further research is recommended to study the interaction of all the other factors that affect gas emissions.

Table 1. Summary of the Parameters for the IRI-Gas Emission Equations

PEMS – Gas Y (g/mile)	m	B
CO_2	1.1074	278.89
CO	0.0023	0.5577
HC	0.0004	0.0644
NO_x	0.0003	0.1039

*Note: Y (Gas g/mile) = m * IRI (in/mile) + b*

Table 2. Maximum Gas Emission Potential Savings Due to Maintenance and Rehabilitation Treatments

Pavement Type	Treatment Category	CO_2 (g/mile)	CO (mg/mile)	HC (mg/mile)	NO_x (mg/mile)
Asphalt	Preventive Maintenance	253.94	516.96	93.60	58.32
	Light Rehabilitation	310.37	631.84	114.40	71.28
	Medium Rehabilitation	239.83	488.24	88.40	55.08
	Heavy Rehabilitation	260.99	531.32	96.20	59.94
JCP	Preventive Maintenance	49.38	100.52	18.20	11.34
	Light Rehabilitation	126.97	258.48	46.80	29.16
	Medium Rehabilitation	155.18	315.92	57.20	35.64
CRCP	Preventive Maintenance	56.43	114.8	20.80	12.96
	Light Rehabilitation	134.02	272.84	49.40	30.78
	Medium Rehabilitation	155.18	315.9	57.20	35.64
	Heavy Rehabilitation	169.29	344.64	62.40	38.88

Note: Vehicle gas savings are reported for CO_2 in g/mi, and for CO, HC, and NO_x in mg/mi (1000 mg/mi = 1 g/mi)

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