Staff summary

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November 2006

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Pavement Smoothness and Fuel Efficiency: An Analysis of the Economic Dimensions of the Missouri Smooth Roads Initiative

MoDOT Summary Statement

It's widely accepted that smooth roads provide greater driver comfort and satisfaction, decreased vehicle maintenance costs, and better fuel economy. Now thanks to a recently completed study, the affect of pavement smoothness on fuel efficiency has been confirmed for Missouri drivers on Interstate 70. Specifically, the study examined the miles per gallon in fuel savings for smooth versus rough pavement.

The study found that a 53 percent improvement in road smoothness, as part of the Smooth Roads Initiative, resulted in a 2.46 percent improvement in miles per gallon for large trucks. With approximately 9,000 trucks per day on I-70, over the course of a year the annual fuel savings would be 3,120,750 gallon of diesel. At the Nov. 16 average price per gallon of $2.56, the annual cost savings would be $7,989,120.

Figure 1, Interstate 70 Pavements Before and After Pavement Resurfacing.

MoDOT Project Overview

Previous research has confirmed a relationship between smooth roads and fuel efficiency[1]. And although this research has had significant variations in results and conditions, the majority of the research supports a positive relationship between smoother road surfaces and greater fuel efficiency. Smooth roads lead to lower rolling resistance and thus greater fuel efficiency.

[1] WesTrack Track Roughness, Fuel Consumption, and Maintenance Costs. Research, Development and Technology, Turner-Fairbank Highway Research Center. January 2000.

MoDOT Project Overview (cont'd.)

MoDOT's study was set up to test real conditions in Missouri and compare dump truck fuel efficiencies on a pavement before and after pavement resurfacing. MoDOT staff drove four, specially instrumented dump trucks on a 22-mile loop of I-70, in Lafayette County, east of Odessa. Before resurfacing, each vehicle was driven more than 50 hours and more than 2,000 miles on the test loop at a target speed of 60 miles per hour. This was repeated after resurfacing.

"Before paving" loops were driven in May 2006, while the "after paving" loops were driven in September and October 2006. The same drivers were used before and after. Dump trucks carried a pair of concrete safety barriers to give them a loaded condition. Great care was taken to ensure that the trucks were in similar conditions for all loops to avoid changes not related to pavement conditions.

Figure 2, MoDOT Test Truck on I-70 Prior to Pavement Resurfacing.

All four trucks were new, tandem-axel, diesel dump trucks. Two of them had automatic transmissions and two had manual transmissions. In order to monitor truck performance, MoDOT used the latest technology for dump trucks, the International Navistar's AWARE system. The AWARE system is an onboard monitoring system that automatically downloads vehicle performance information, including miles of travel and fuel consumption. A 2004 gasoline SUV was also included in the test-driving to substantiate the direction of the results.

The International Roughness Index was used as a proxy for pavement smoothness and was measured with the Automated Road Analyzer (ARAN) van. The average International Roughness Index (IRI) before paving was moderately rough at 130.23. After paving, the pavement IRI was smooth at 60.99. This represents more than 53 percent improvement in smoothness.

MoDOT Staff Findings

Before paving, the diesel dump trucks averaged 5.97 miles per gallon. After paving the trucks averaged 6.11 mpg. This 0.14 mpg improvement represents more than 2.4 percent mpg savings. The gasoline powered SUV averaged 21.3 mpg before and 21.47 mpg after, a 0.17 mpg improvement or slightly less than one percent savings. While these numbers are small per vehicle, with the number of vehicle miles driven on the smoother roads from SRI, these savings represent millions of gallons of fuel saved, per year.

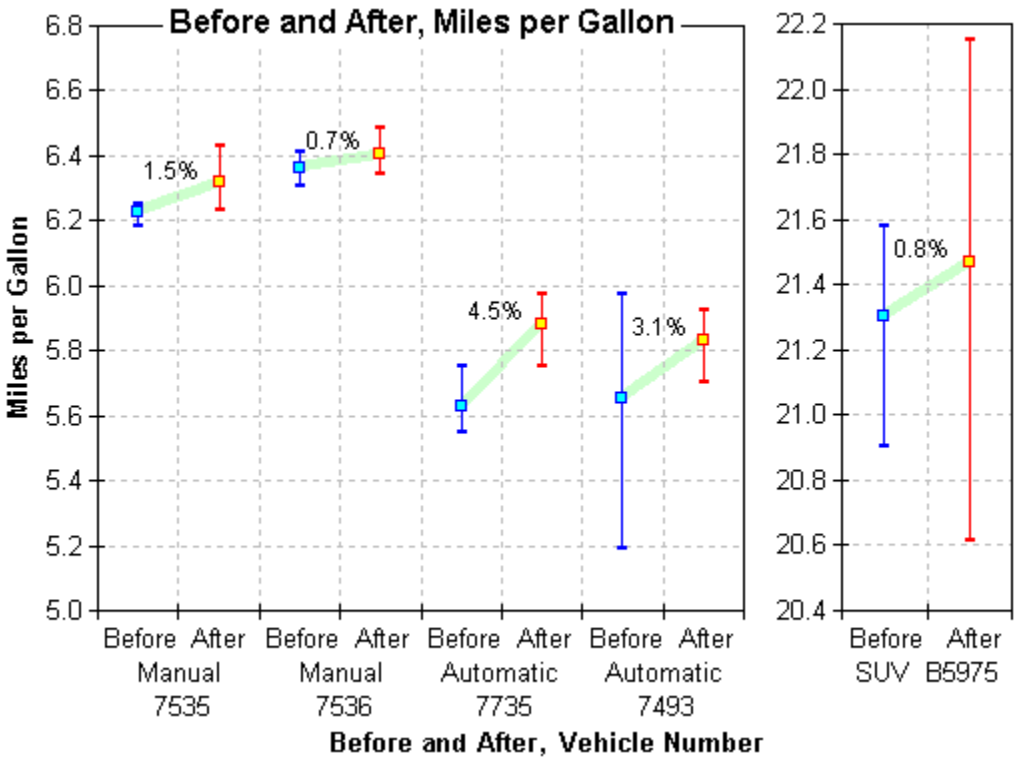

Figure 3, Graph of Minimum, Maximum, and Average Miles per Gallon Changes.

Consider trucking on just I-70 alone, about 10 percent of the total 2,200 Smooth Road Initiative miles, with approximately 9,000 trucks crossing the state daily. For the 249-mile trip across the state from I-70/I-55 in St Louis to I-70/I-35 in Kansas City, each tractor-trailer rig gets approximately 6 miles to the gallon[3], so they use 41.5 gallons of diesel fuel crossing Missouri. And if we add the smooth roads factor of 2.46 percent increase in mileage per gallon of fuel, each truck uses only 40.55 gallons of fuel or .95 gallons less fuel per trip across the state. On a per day basis with 9,000 trucks, this equates to a fuel savings of 8,550 gallons per day. On a per year basis, this equates to a fuel savings of 3,120,750 gallons of diesel fuel saved per year. To the truckers and trucking industry, at a current average diesel price of $2.56 per gallon as of November 16, 2006, this equates to a yearly saving of $7,989,120.

[2] http://www.tripnet.org/RoughRideReportOct2006.pdf

Conclusions

Smooth roads make sense in Missouri.
Previous research tells us that rough highways cost us money in increased vehicle operating costs. The non-profit organization, TRIP, estimates that driving on roads in need of repair costs the average urban driver $383 each year.[2] Missouri's advanced planning process and statewide customer satisfaction surveys indicate customers want a smooth ride. In fact, it's not too much of a stretch to suggest that customer satisfaction with ride quality is equal to overall satisfaction with MoDOT.

Savings add up!
The Smooth Roads Initiative on I-70 is only a little over 10 percent of the Smooth Roads Initiative (based on miles of pavement). So these small saving add up. The efficient management of our transportation system adds up to tremendous cost efficiencies – literally saving travelers millions of dollars per year - at least 7 million on I-70 alone for only tractor-trailers.

Figure 4, Close-up of Pavements Before and After Resurfacing.

[3] http://www1.eere.energy.gov/vehiclesandfuels/pdfs/program/21ct_roadmap.pdf