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SMOOTHNESS MATTERS

Smooth Pavements Save Fuel
and Even Small Changes Can
Make a Big Difference



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SMOOTHNESS MATTERS

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EXPERTS SAY THAT VEHICLES CONSUME LESS FUEL WHEN TRAVELING ON SMOOTHER PAVEMENTS.

This makes sense intuitively. And, lower consumption of fuel conserves natural resources for a healthier environment.

OUR COUNTRY HAS 2.5 MILLION MILES OF PAVED ROADS.

» Since Americans drive many miles per year, just a slight change in fuel economy per vehicle would result in dramatic fuel savings, conserving our natural resources and benefiting the traveling public.

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THE SMOOTHNESS DIFFERENCE

One compelling principle: Pavement smoothness is a significant determinant of vehicle fuel economy. The smoother the pavement, the lower a vehicle's fuel consumption.

While auto makers continue to make progress on improving fuel efficiency of the engines in the vehicles they manufacture, researchers and state transportation agencies are looking at additional ways to reduce emissions. One area of study is the influence that pavement smoothness (or conversely, roughness) has on vehicle fuel consumption. This brochure provides an overview of how the right pavements can reduce fuel consumption.

Three pavement characteristics that researchers are exploring in an effort to reduce vehicle fuel consumption include tire-pavement rolling resistance, pavement stiffness, and pavement smoothness.

1. Rolling Resistance: 1 Percent or Less

Rolling resistance is the loss of a vehicle's energy due to contact between the tires and the pavement. The loss of energy due to rolling resistance is small, about 15 to 20 percent, compared to other forces such as wind resistance. It is estimated that a 5 to 7 percent reduction in rolling resistance - typical changes attributed to tire air pressure or tire baldness - only increase automobile fuel efficiency by less than 1 percent.

2. Pavement Stiffness: Minimal Effect

The pavement's stiffness, an indicator of strength, accounts for between 0.005 percent to 0.5 percent difference in fuel consumption, depending on the vehicle type (e.g., automobile vs. tractor-trailer). Because these are very low estimates based on theoretical calculations, the effect of pavement stiffness on vehicle fuel consumption is minimal, at best.

3. Pavement Smoothness: 5 Percent or Better

Pavement smoothness affects rolling resistance by influencing friction between the tire and the pavement. The most thorough investigation of this issue was a full-scale field study conducted by the Federal Highway Administration at the WesTrack pavement test track in Nevada. This study indicated that trucks running on slightly smoother pavement could reduce fuel consumption by 4.5 percent. Other studies show similar or sometimes greater fuel savings with cars running on smoother pavements. The savings are even greater when one compares the roughest pavements in a highway network with the smoothest. Some experts estimate that it is possible to reduce fuel consumption by as much as 10 percent by rehabilitating the roughest pavements.

Not only do smoother pavements reduce fuel consumption, they also reduce vehicle operating costs and driver fatigue by minimizing tire bounce and load impacts. According to figures developed by The Road Information Program (TRIP), driving on rough roads costs our nation's motorists \$23 billion annually in extra vehicle operating costs.

Smoother pavements also last longer because trucks' tires roll along the pavement instead of bouncing on bumps - and such bouncing actually accelerates the rate of road deterioration. Studies show that improving pavement smoothness by 25 percent results in almost a 10 percent increase in pavement longevity. By lasting longer, smooth roads save taxpayers money while they also conserve precious natural resources.

For all these reasons, smoothness matters.

WHAT ABOUT CONCRETE?

There have been claims from cement/concrete promoters that concrete pavements save fuel. However, because 94 percent of America's roadways are surfaced with asphalt, it is difficult to directly compare asphalt pavements to concrete pavements. A meaningful comparison would require data from a tightly controlled experiment. Differences in traffic flow, terrain, smoothness, wind, temperature, tire inflation pressure, driver behavior, and a host of other factors must be accounted for in the results.

Over the years, the cement/concrete industry has sponsored research projects to study the effect of pavement type (concrete vs. asphalt) on vehicle fuel consumption. A critical review of these studies, however, reveals that the results are based upon comparisons of apples and oranges – the pavements studied are not equivalent. More importantly, the results of these studies reinforce the well-established fact, consistent with the WesTrack project, that pavement roughness, not pavement type, is responsible for differences in vehicle fuel consumption.

ASPHALT IS SMOOTHER

Nearly all states have smoothness standards for newly built roads. If the road does not meet the standard, the contractor's pay is reduced. Some states have different standards for asphalt and concrete, and in every state where this is the case, the requirements for asphalt roads are more stringent than for concrete roads. As noted in a 1999 General Accounting Office report to Congress, "Concrete roads may produce rougher readings than asphalt roads, even if the concrete road is of very high quality. Features such as joints between sections can contribute to the roughness of concrete highways."

BUILDING SMOOTHER TO STAY SMOOTHER AND IMPROVE FUEL EFFICIENCY

Keeping a road smooth begins with a well-engineered foundation and pavement structure. An asphalt "perpetual pavement" is designed and built to ensure that the structure lasts virtually indefinitely. Routine maintenance is simply a matter of infrequently milling the surface for recycling, followed by placing a smooth new asphalt overlay, about every 12 to 20 years. Not surprisingly, these periodic improvements in ride quality significantly reduce fuel consumption of vehicles traveling these roads. **Bottom line: asphalt pavements are easier to keep smooth.**

Americans burn 175 billion gallons of fuel driving 3 trillion miles a year. If we could make the roads across the nation slightly smoother, we could likely save at least 4 percent of the fuel consumed. This could reduce annual vehicle fuel consumption by about 7 billion gallons, equivalent to taking over 10 million vehicles off the road every year. This would reduce the amount of fuel and vehicle maintenance required for every traveler on our roads, in addition to conserving our natural resources and benefiting our environment.

THE FACTS ARE CLEAR

After closely examining the available research and investigating a variety of different factors, one thing is clear: of all pavement characteristics, smoothness is the major determinant of vehicle fuel economy. **Simply stated, the smoother the pavement, the less fuel consumed by the vehicle.**

For a full discussion of studies on this topic, see the below-referenced article.

Marks, Howard, PhD. 2009. Smoothness Matters: The Influence of Pavement on Fuel Consumption. Hot Mix Asphalt Technology Vol. 14, No. 6, pp. 18-29, available at www.nxtbook.com/nxtbooks/naylor/NAPS0609/index.php#/18