



The forces that **Matter** for **Pavement-Vehicle Interaction**

Almost 75 percent of the oil consumed in the United States is used as vehicle fuel.¹ Despite increases in vehicle fuel economy over the past few decades, fuel costs remain a significant budget item for the public and businesses alike. Numerous factors influence the fuel economy of a vehicle — its aerodynamic properties, engine, tire pressure, and air temperature; however, just three basic forces impact fuel economy: vehicle internal friction, air drag, and rolling resistance. While these three forces always affect fuel economy, they vary in importance based on the vehicle speed,² in addition pavement factors only truly have an impact on rolling resistance.

The rolling resistance forces a vehicle must overcome to maintain speed are linked to its suspension system, bearings, transmission, tire pressure, and in part, the properties of the pavement. Three pavement properties are commonly understood to influence rolling resistance:



Surface texture
the roughness of the
aggregate materials in
a pavement



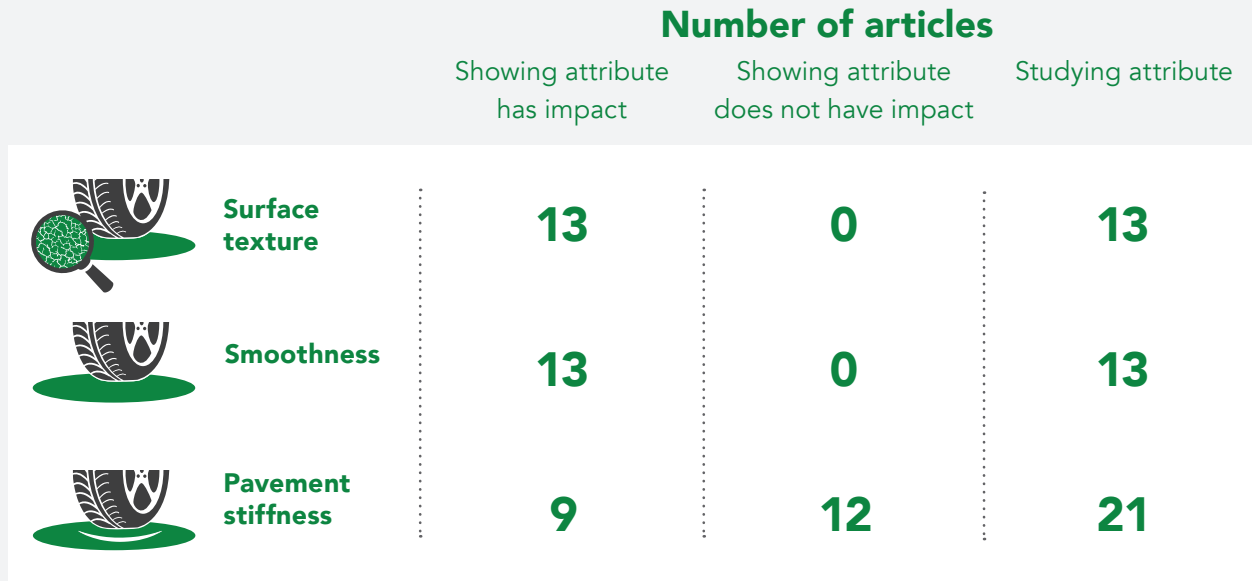
Smoothness
surface unevenness
that affects perceived
ride quality



Pavement stiffness
how the pavement deflects
under a vehicle's weight

Research has been conducted over the past 40 years to determine how each of these three properties affects rolling resistance. Pavement texture influences fuel economy through the interaction of the tire and the contacted area of the pavement. As the tire deforms, energy converts into heat, which is lost to the rest of the tire and the atmosphere. Pavement stiffness may influence rolling resistance because when tires and pavements interact the pavement compresses causing the tire to continually drive “uphill.”³ Smoothness influences the fuel consumption through energy lost by the shock absorbers and tires as the vehicle moves down the roadway and these systems work to the make the ride more comfortable.

A recent study conducted by NCAT compiled 40 years of research into a single report to develop an understanding on the state of the science.⁴ This synthesis shows that science continually demonstrates that texture and smoothness influenced the rolling resistance of pavements; however, only nine of the 21 studies indicated that pavement stiffness has a direct influence on rolling resistance which might be considered significant. Due to the different results of these studies, more information is needed before incorporating pavement type in rolling resistance calculations.



According to FHWA, when considering what is most critical to the highway system, “Roughness as measured by IRI generally has the greatest effect on fuel economy for typical ranges of IRI on U.S. highway networks.”⁵ The best way to provide the driving public with the greatest possible fuel economy from the pavement infrastructure is to design and maintain smooth roadway networks. In addition to aiding the driving public, smoother pavements increase pavement longevity and require less maintenance than rougher roads.⁶ Review NCAT’s report for the full literature review which shows the state of knowledge surrounding pavement–vehicle interactions, as well as current limitations based on the available studies.⁴

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