The Importance of Pavement Smoothness

IGGA
International Grooving & Grinding Association
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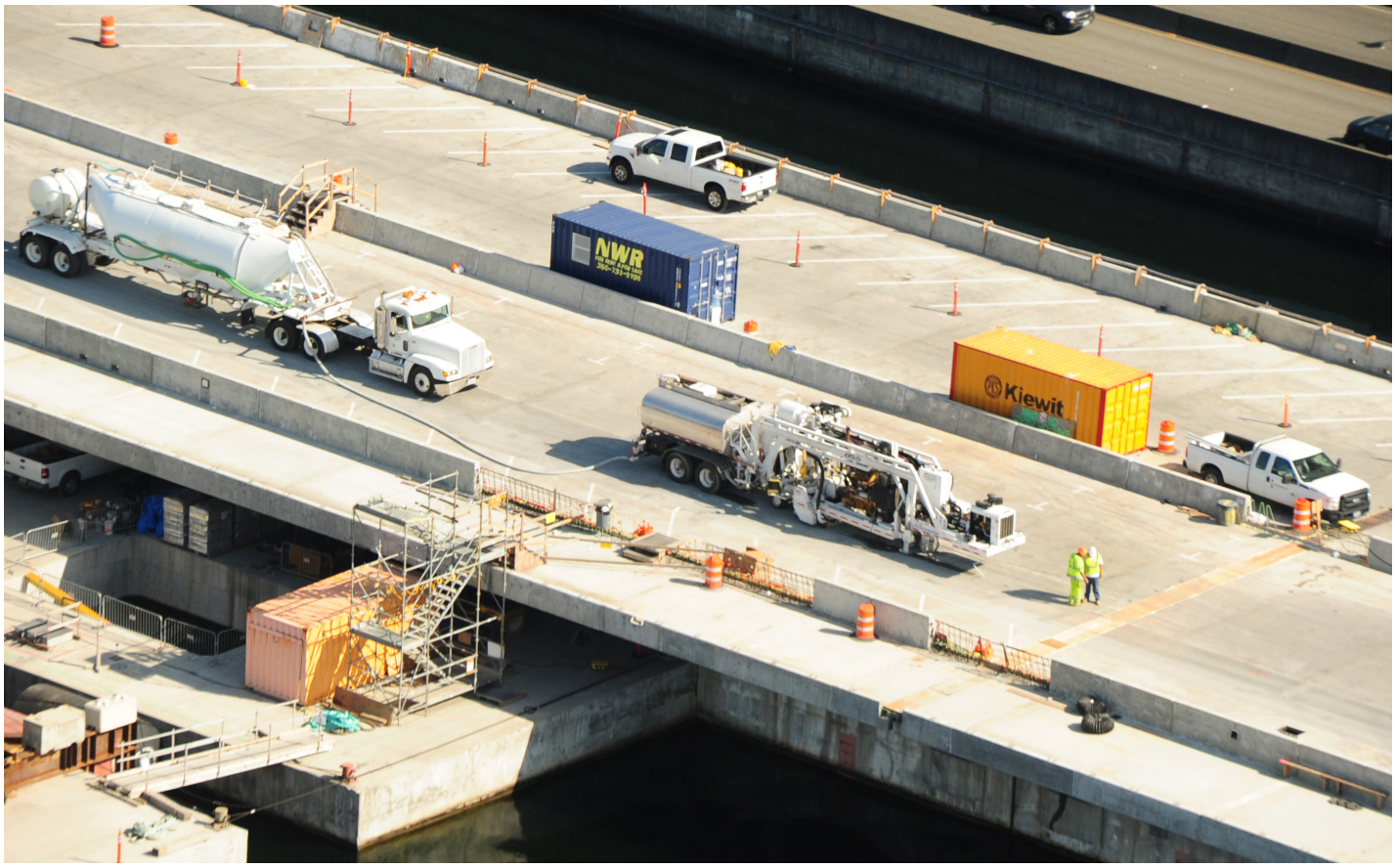
Pavement smoothness is more than just a finishing touch. It is integral to pavement performance.



Smooth pavement lasts longer, is safer, provides better ride quality – and some studies suggest it may be greener.

>>> DIAMOND GRINDING AS A SOLUTION

THE IMPORTANCE OF SMOOTH ROADS has always been a concern for road builders, beginning with the Romans and their use of surveyors' chorobates to ensure level roadways. Over time, increasingly sophisticated devices were developed. Today, inertial profilers are commonly used to measure pavement smoothness.

The AAHSO road tests conducted between 1958 and 1960 developed the concept of serviceability and provided the first direct linkage between pavement design and the smoothness of roadways. The importance of smoothness is further exemplified by the FHWA's soon-to-be-implemented performance measures, which will include smoothness requirements for each of the states' roadway networks.

Since the 1960s, diamond grinding has proven to be the most effective procedure used to improve smoothness on newly constructed portland cement concrete pavement (PCCP). Research has shown that the smoother a pavement is initially, the better it will perform over time and the longer it will last. Diamond grinding can significantly improve smoothness of both newly constructed and existing pavements. It is for this reason that several state Departments of Transportation in the United States are now specifying diamond ground surfaces as the final surface on newly placed PCCP. Similarly, diamond grinding is perhaps the most common pavement preservation strategy used today.

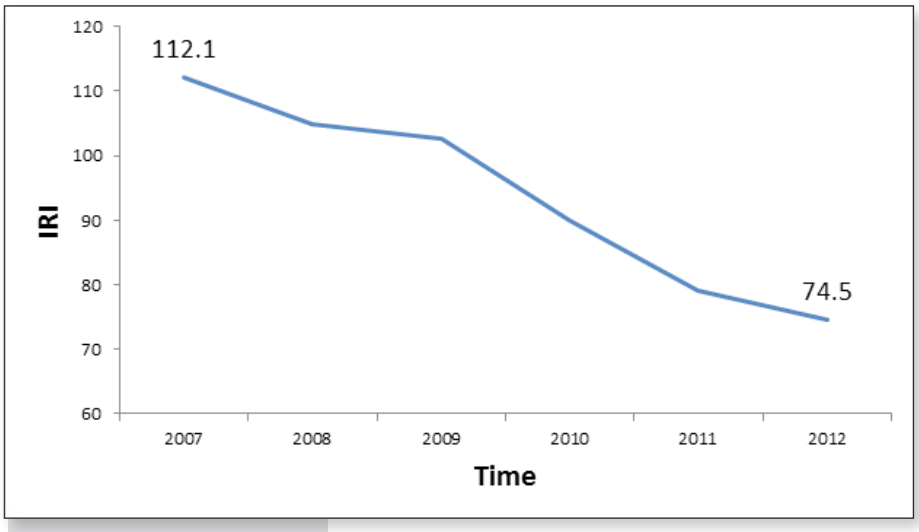


Fig 1: IRI measurements for Kentucky's interstate concrete pavements improved from an average of 112.1 in/mile to an average of 74.5 in/mile – the longest sustained improvement in the state's IRI and their lowest recorded average IRI ever.

>>> SUCCESSFUL CONCRETE PAVEMENT PRESERVATION

Since 1995, the FHWA has required states to collect their performance monitoring data using a roughness statistic called the International Roughness Index (IRI). Today this measurement is almost universally used by all state agencies as a performance metric for their pavement management systems.

Measuring roughness and establishing an IRI threshold as a trigger value can be a valuable way for states to manage their concrete preservation (versus merely providing maintenance after extensive repairs become necessary). As an example, the state of Kentucky uses inertial profilometers annually to measure roughness on its interstate system, and IRI values greater than 130 in/mile will generally trigger concrete pavement preservation (CPP).

Between 2007 and 2012, Kentucky diamond ground 536 interstate lane miles, primarily in the Louisville area. During this period, IRI measurements for Kentucky's interstate concrete pavements improved from an average of 112 in/mile to an average of 75 in/mile — the longest sustained improvement in the state's IRI and their lowest recorded average IRI ever (see Fig. 1). The improvement was attributed to the 536 miles of diamond grinding.

The combined cost of the diamond grinding projects (including traffic control, patching, joint resealing, etc.) was $101 million, or $188,000 per lane mile. Reconstruction costs would have been an estimated $1.5-$2.5 million per lane mile, so CPP saved the state over $1 billion. The expected pavement life extension for ground pavement is 10 to 15 years. The average cost of diamond grinding in Kentucky during this 5 year period was $2.75 per square yard.

>>> SMOOTHNESS AS A PATH TO SUSTAINABILITY

Although recognizing that concrete pavement already represents a sustainable road surfacing option, researchers at the Massachusetts Institute of Technology's (MIT) Concrete Sustainability Hub sought to establish ways in which its environmental impact could be reduced even further. They examined not only material production and construction of concrete pavement, but costs throughout its life cycle.

One item of particular interest was the effect that different pavement properties have on vehicle fuel consumption. To assess this, the team developed a model of this phenomenon and test results identified two key factors that influence how pavements affect fuel consumption: deflection and roughness. Deflection of a road surface creates slight depressions that vehicles have to use additional force to roll out of. Extra fuel is required to exert that force and, over many miles, this adds up. Pavement roughness causes a similar situation, in which too many points of contact between the tire and the pavement are eliminated. In addition to negatively impacting vehicle control and safety, the uneven contact increases the rolling resistance, and thus the amount of fuel required to overcome the resistance. The MIT team also noted that deflection has the most impact on trucks and heavy vehicles, while roughness has the greatest effect on fuel consumption for cars.

According to the Concrete Sustainability Hub, these inefficiencies are causing an estimated 700 million gallons per year of excess fuel consumption on the U.S. road network. The majority of that excess is caused by pavement roughness.

To further confirm their modeling approach, they evaluated segments of the Virginia Road network. In this research they created a map illustrating fuel consumption magnitudes at different locations throughout the state. Hub researchers found that only 1.3 percent of Virginia's analyzed interstate network was responsible for 10 percent of the excess fuel consumption. This was interpreted to mean that pavement rehabilitation—improving smoothness and stiffness — in the small percent of roadways most affected would result in significant fuel savings.

From the beginning of road building, smoothness has been the most important consumer pavement characteristic. In addition, it impacts pavement design and performance and will soon be a requirement mandated by the FHWA. As roadways become smoother and smoother, vehicle operating costs are reduced and fuel economy is improved.

ABOUT IGGA

The International Grooving & Grinding Association (IGGA) is a non-profit trade association founded in 1972 by a group of dedicated industry professionals committed to the development of the diamond grinding and grooving process for surfaces constructed with Portland cement concrete and asphalt. In 1995, the IGGA joined in affiliation with the American Concrete Pavement Association (ACPA) to form what is now referred to as the Concrete Pavement Preservation Partnership (IGGA/ACPA CP3). The IGGA/ACPA CP3 now serves as the lead industry representative and technical resource in the development and marketing of optimized pavement surfaces, concrete pavement restoration and pavement preservation around the world.