THE UNIVERSITY OF TEXAS AT AUSTIN ✦ COCKRELL SCHOOL OF ENGINEERING

TEXAS PAVEMENT PRESERVATION CENTER

TxDOT Newsletter

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Our Mission

The mission of the TPPC, in joint collaboration with the Center for Transportation Research (CTR) of the University of Texas at Austin and the Texas Transportation Institute (TTI) of Texas A&M University, is to promote the use of pavement preservation strategies to provide the highest level of service to the traveling public at the lowest cost. The executive sponsor for the TPPC is the Texas Department of Transportation (TxDOT).

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Past and Upcoming Events

National Pavement Preservation Conference
August 27-30, 2012 │ Nashville, TN

The First National Pavement Preservation Conference was held on August 27-30, 2012 in downtown Nashville, Tennessee at the Renaissance Nashville Hotel. Conference sessions featured seven tracks which take a multi-faceted approach to pavement preservation ranging from the details of individual treatments to the intricacies of managing large and small networks; educating and informing the public and elected officials; innovation and research; economics; and environmental protection. This conference offered pavement practitioners an opportunity to hear from experts in the preservation field through plenary and technical sessions. There the placements of several types of pavement preservation treatments was demonstrated. Individual perspectives from leaders of the preservation industry, government, and academia were presented about the need to protect our roadway investment through preservation. An important part of this conference was the participation of vendors who offer pertinent products and services and shared the latest information about hundreds of products and services available for pavement preservation programs and applications.

Courses for 2012

TPPC has developed two new courses for 2012. One of the courses is titled “Use of Thin Surfacing for Pavement Preservation,” and the other is “Construction of Thin Hot Mix Asphalt Overlays.” Both courses will be taught by Cindy Estakhri, TTI research engineer, and Dr. Yetkin Yildirm, director of the TPPC. For more information, please visit our website at: www.utexas.edu/research/tppc

TPPC Board of Directors

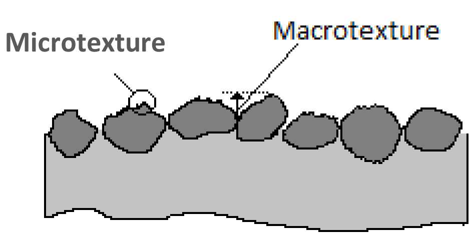
Pavement Friction

Safety and efficiency related issues of roadways are of vast importance for the public safety and economy of the US According to the 2009 ASCE records on US infrastructure, 14,000 US citizens out of 41,059 were killed in motor vehicle crashes due to poor road and highway conditions. In addition, more than 2,491,000 people were injured in vehicle crashes.

Surface texture and friction are the main factors affecting the safety of pavements. The friction force that develops between the tire and pavement surface is an essential part of the vehicle-pavement interaction; it gives the vehicle the ability to stop safely. The greater the frictional resistance, the quicker the vehicle can be slowed or stopped. Skid resistance is the friction force which develops at the tire-pavement contact area. Many factors influence the level of skid resistance on a paved road such as: microtexture and macrotexture, age of the road surface, seasonal variation, traffic intensity, aggregate properties, and road geometry. The macrotexture of the pavement surface is related to mixture design, compaction level, as well as aggregate gradation. The microtexture is related to the texture and shape characteristics of aggregates. Pavement texture is defined as a road surface property that describes the interaction between the road surface and vehicles tires.

When in a dry and clean state, roads generally provide insignificant differences in friction levels, regardless the type of pavement and surface configuration. Hence, the operation on dry runway surfaces is mostly satisfactory. Many studies have revealed that 15 to 18 percent of traffic crashes occur on wet pavements. Friction is one of the primary factors affecting the performance of asphalt pavements in wet conditions. When in this state, the water acts as a lubricant between the pavement surface and the tires – which reduces friction. For this reason, most of the equipment dealing with pavement friction measurement operates in wet conditions.

Microtexture and macrotexture greatly influence the skid resistance of road surfaces. The figure below illustrates the difference between microtexture and macrotexture. Pavement macrotexture provides good drainage of water from the pavement surface. Microtexture, on the other hand, provides the direct contact between the tires and road surface and contributes to the adhesion part of the pavement friction. Pavement with rougher texture provides better skid resistance; however, it may increase noise, vibration, and tire wear.



Microtexture and Macrotexture

Aggregate, being part of asphalt mixtures, plays a major role when it comes to skid resistance. The aggregate properties such as gradation, shape, and mineralogy, dictate its ability to resist polishing action by traffic. This ability to resist polishing is the most significant characteristic to skid resistance of pavement surfaces. Hogervorst (1974) explained that skid resistance changes with vehicle speed, and it depends on both microtexture and macrotexture. The results of this study showed that the skid resistance decreased as vehicle speed increased, and pavements with a coarse and rough surface provided better skid resistance compared to those with fine and polished surfaces.

Because of the great importance of pavement surface skid resistance, many pieces of testing equipment are developed and correlated to each other in order to measure friction. The need for improvement of pavement friction performance in existing roads has led to the development of different treatments like shot-abrading, grooving, grinding, and overlays. These topics were presented in more detail at the workshop "Pavement Friction Restoration Using the High Velocity Impact Method" which was held at the Center for Transportation Research.

Pavement Friction Workshop – May 2, 2012

The workshop "Pavement Friction Restoration Using the High Velocity Impact Method" took place at the Center for Transportation Research at the University of Texas on May 2, 2012, and was sponsored jointly by Skidabrader and the Texas Pavement Preservation Center. The workshop featured presentations by Gary Billiard, president of Skidabrader, titled "Friction and Texture Enhancement;" Thomas Yager from NASA Langley Research Center, titled "Current Status of Roadway and Runway Friction Evaluations;" and Dr. Yetkin Yildirm, director of the TPPC, titled "Pavement Preservation and Texture."

Workshop Presenters: Thomas Yager, Dr. Yetkin Yildirm and Gary Billiard

Dr. Yildirim commenced the workshop by outlining the importance of pavement preservation and resurfacing techniques. While proper maintenance practices encourage cost-efficient preservation, the primary goal of maintaining healthy pavements is that of safety. Roadway safety can be enhanced by applying the right preservation treatment at the right time, thus preserving structural integrity, enhancing pavement performance, retarding progressive failures, and improving ride quality. However, safety standards and remedial actions can be established only with education and training of industry professionals and policy makers.

In his presentation "Friction and Texture Enhancement," Gary Billiard shared the Skidabrader surface re-texturing process. Sufficient roadway friction is an important factor for both highway and runway safety. Skidabrader provides a time and cost-efficient resurfacing process. The Skidabrader machine is equally efficient on PCC and asphalt surfaces, and its bi-directional texturing process produces an unmatched level of surface uniformity, which has proved to be effective in accident reduction. Additionally, the process is environmentally clean and self-contained, resulting in an ability for day or nighttime operations and few traffic disruptions.

During his presentation, Mr. Yager shared his many years of experience in improving runway and highway friction. His presentation explored the development of friction evaluation methods and techniques throughout history, current and newly developed equipment used in conducting these evaluations, classification of pavement surfaces in terms of friction levels, and the treatments available to increase pavement friction performance.

Considerations of commuter safety occupy a prominent role in each of these presentations. Together, these presentations make a clear case for maintaining surfaces with a high level of friction. Maintaining the ideal (safest) surface can be accomplished with simple, non-invasive retexturing projects.

Current Status of Roadway and Runway Friction Evaluations

presentation by Thomas Yager

Mr. Yager's presentation explored the development of friction evaluation methods and techniques throughout history, current and newly developed equipment in conducting these evaluations, the classification of pavement surfaces in terms of friction levels, and treatments available to increase pavement friction performance.

History of Friction Measurements

In the Horse Era, or late 19th century, the quality of pavement friction was measured by counting the number of miles traveled by horse over different types of cobblestone pavement before an accident occurred. They classified slipperiness by falls on the knees and haunches, complete falls, and those of other unspecified types. The available data from 1873 and 1885 reveals the slipperiness of each type of pavement in England and America, respectively.

The American data quantifies different types of falls according to different types of pavement—asphalt, granite, and wood—while the English data quantifies falls according to differing weather conditions on the same type of pavements.

Pavement Friction "Horse Era"

With the advent of cars in the 20th century, roadway friction was tested by placing a lunch box on the passenger seat and “measuring” whether or not it stayed there. The driver accelerates up to 30 mph and slams on the brakes, locking all four tires momentarily. If the lunch box falls off the seat, the tire/pavement friction is deemed acceptable; if the lunch box remains, remedial treatment is required.

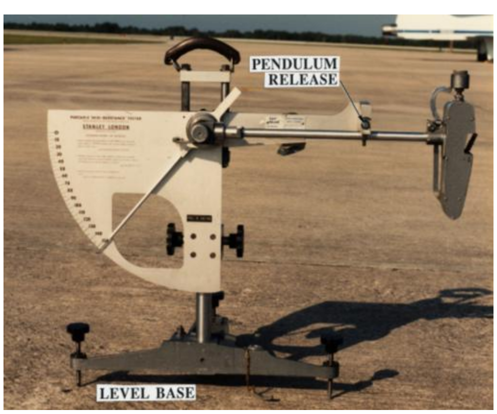
Today's Testing Equipment

Current friction measurements make use of a number of different vehicles and trailers. NASA’s Mobile Tire Test Facility has replaced the older Instrumented Tire Test Vehicle while Runway Friction Tester, Airport Surface Friction Tester, and the Canadian Electronic Recording Decelerometer Vehicle have replaced the Diagonal Braked Vehicle. Friction measuring trailers include the IMAG Variable/Fixed Slip Trailer, the Norwegian Runar Variable/Fixed Slip Trailer, the Scottish GripTester Fixed Slip Trailer, the BV-11 Skiddometer, the English Mu-meter, and the E-274 Skid Trailer. New devices for measuring friction include NAC Friction Tester, Russian AFT-3 Trailer, Halliday RT3 Trailer, TWO Friction Trailer, and the Dynamic Friction Tester. Most of these instruments use bolt tires. That’s because this type of tire is wear-resistant, which brings the focus to what the pavement is doing rather than what the tire is doing. Therefore, a better understanding of surface – or how much it’s been degraded – is gained. Speed plays an important role in this evaluation, so, normally, the test on runways is carried out at more than one speed. 40 mph is the most probable speed, but tests are also developed for 20 mph and 60 mph. Through all these tests, devices are correlated to each other and to vehicle performance.

TWO Friction Trailer

Dynamic Friction Tester

A number of techniques and devices are used for measuring pavement texture, including the grease sample techniques, the sand patch technique, the British pendulum, the outflow meter, and the circular track meter.



British Pendulum Texture Measurement Device

NASA's correlation of over 10,000 data sets on nearly 100 wet pavement surfaces reveals an inversely proportional relationship between the pavement friction coefficient and the speed of the vehicle. The data suggests that the slope of the graph is a function of the macro-texture of the pavement, while the magnitude of the friction coefficient is a function of the micro-texture.

NASA Mobile Tire Test Facility

"Friction coefficient" is a product of the drag force between the tire and the pavement, divided by the vertical force, which is a dimensionless coefficient. Most of the friction-measuring devices try to maintain a slip level between 10 and 20%. By slip level, or slip ratio, it is understood that the tires at 10% slip actually rotate 10% less than the forward speed of the vehicle. So, if the vehicle is going a 100mph, the test tire will be turning at 90mph.

Pavement surfaces are classified into five categories according to the probability of hydro-planning, which is evaluated using the grease sample and sand patch techniques in addition to the outflow meter measurements. The deeper the macro-texture of the pavement as measured by the two techniques, the lower the chance of hydro-planning.

Improving Friction Properties

Different treatments may be applied in order to improve the friction performance of pavement. These include shot-abrading, grooving, grinding, and overlays. Overlays are further divided into micro-surfacing, slurry seals, rejuvenators, and porous friction courses.

Shot abrading, such as the Skidabrader system, is not only a good way to improve road texture and draining capability, it can also be used to smooth the pavement texture, increasing ride quality. Transverse-pattern grooving is mainly used on runways in order to take advantage of the crown, which is found on the runway surface, therefore promoting drainage to the shoulders. And for highways, longitudinal-pattern grooving is widely used to improve side force on curves, lowering the chance of sliding accidents.

Grinding has gained a lot of popularity in recent years, not only from a ride-quality standpoint, but also in regards to wet friction properties, too. It can improve non-grooved or non-smoothed pavement surfaces, or even wet-friction performance, as much as 25%. Basically the grinding ends up giving you a shallow finish which is rigid; and it can remove bumps, giving you a better ride quality as well as wet-friction performance.

Friction and Texture Enhancement
presentation by Gary Billiard

Gary Billard's presentation introduced the Skidabrader machinery and procedure to workshop attendees. The Skidabrader process revitalizes friction properties of both asphalt and PCC pavements on both highways and runways through a process of retexturing the riding layer of pavement surfaces.

The *Skidabrader* Process

The Skidabrader machinery fires 4000 lbs./min. of steel shot at the road surface in order to retexture it. This retexturing increases friction, improves drainage, and reduces spray in wet-weather conditions. The Skidabrader truck vacuums and recycles the steel shot so that no shot remains on the road or runway after the Skidabrader process is complete. In certain projects, the Skidabrader truck is followed by a vehicle mounted with an electromagnet in order to collect any and all stray shot that was not recycled by the Skidabrader truck.

Skidabrader Steel Shot

Macro- vs. Microtexture

When judging a surface's friction, both microtexture and macrotexture must be taken into account. The macrotexture of a surface is the large-scale texture (up to a 50mm length sample of the surface). And it's this characteristic of macrotexture that contributes to water-drainage properties of pavement surfaces. Uniform macotexture will result in greater amounts of standing water on pavement, and thus a greater risk of hydroplaning and spray. A variable macrotexture, however, will allow water to drain from the pavement, reducing wet-weather condition safety risks. The microtexture of a surface is the small-scale texture (smaller than .5mm length sample of the surface). This characteristic of microtexture is what provides the majority of adhesion during braking or at low speeds. A good microtexture can be achieved through surface irregularities of individual aggregate particles. The Skidabrader's shot system is able to produce a high level of variability in the surface microtexture.

Macrotexture (grey) and Microtexture (yellow)

Outflow Meter Test

Skidabrader personnel employ a number of quality control tests during and after the Skidabrader process. Their most common quality control test is completed using an outflow meter applied to a freshly abraded pavement surface behind the Skidabrader truck. In these tests, an outflow meter filled with water is placed on the pavement surface. The time that it takes for all of the water to flow from the meter is measured. If the pavement surface has poor drainage, then the water will take a long time to drain from the outflow meter. TxDOT requires that their roads maintain a 9 second or faster outflow time. Skidabrader personnel perform their testing in order to make sure that their process is leaving a surface that achieves outflow times of 6 seconds or less.

Outflow Meter Device

The Skidabrader system provides an alternative to resurfacing for roads that are in need of an improved friction coefficient but are otherwise still in good condition. Skidabrader will not improve the structural integrity of a pavement, only the friction properties. Skidabrader would not be a viable option for roads in need of restoration or maintenance, but improving friction, drainage and safety properties of a pavement surface can all be achieved through the Skidabrader process.

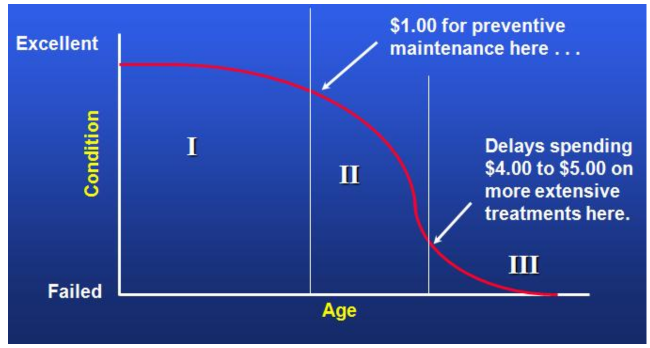
Texture and Pavement Preservation
presentation by Yetkin Yildirim

In his presentation, Dr. Yilidrim discussed pavement preservation and how preservation practices are related to friction concerns. There are many methods of pavement preservation. Most of these methods are applied directly on top of the road. As a result friction properties and safety considerations are closely tied to preservation practices.

Side by Side Comparison - Before and After Preservation Treatment (PFC Overlay)

As defined by the FHWA, pavement preservation is a program which employs a network level, long-term strategy that enhances pavement performance by using an integrated, cost-effective set of practices that extend pavement life, improve safety, and meet motorist expectations. It is important that preservation practices take into account the entire road network, that they provide a cheaper alternative to reactive maintenance, and that they satisfy the commuting public by improving safety and ride quality.

Pavement preservation methods include all techniques which extend the life of a pavement through improvement of its surface condition without affecting the structural capacity. Therefore, preservation is only useful for pavements that are structurally sound, have good drainage and acceptable thickness. Selection of the right pavement is essential for achieving positive results. It is a proactive approach in comparison to a reactive maintenance approach. Preservation practices can fix top-down cracking, minor rutting problems, and can achieve improvements to friction properties. Research suggests that every $1 spent on preventive maintenance techniques saves $5 on major rehabilitation. The critical factor for a successful pavement preservation program is the application of the right treatment at the right time.



Pavement Service Life Stages

Preservation and Safety

In surveys conducted around the country, the most important aspect of road maintenance for the general public is that of safety. In order to meet the public's standards, preventative maintenance programs must concentrate on achieving better riding surfaces which have fewer ruts and raveling while also striving for less disruptive repairs for commuters. Preventative maintenance using PFC mixes are capable of reducing the risk of hydroplaning, drains water from the road quickly, reduces spray and glare, improves visibility of road markings, and provides of road coarseness which improves the friction properties of the riding layer of a pavement. Such preventative practices can achieve these goals better than reactive maintenance which requires more expensive and disruptive construction practices.

Porous PFC Mix Asphalt